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MASTER's Degree Thesis

Internal Credit Risk Models applied to Bank Mergers A practical case of Incorporation

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1) Introduction

The banking sector has always played a major role in the global economy and, now more than ever, it is facing increasingly difficult challenges. The recent financial crises have highlighted the fragility of the sector, which is not sufficiently resilient yet and unable to adapt to continuously changing and dynamic markets. While the consequences of such crises have underlined the weaknesses of credit and banking institutions, they have also laid the foundations for a complete restructuring and review of the regulations that guide them, creating a fairer and more stable system. In this context, bank mergers have played an essential role and are one of the main outcomes of this process. Increasingly stringent regulations and the rising costs of digitalisation in recent years have led to an unprecedented increase in mergers and acquisitions, forcing smaller banks to merge with each other. The resulting benefits of these processes include possibility of pooling resources, increasing the market share and decreasing the operating costs. Among all the facets that characterise a bank merger - and especially mergers by incorporation as examined in the present document - the present work will focus on the area of credit risk management and in particular on the use of internal credit risk models adopted by a bank as a tool for clients' assessment.

The motives that led me to investigate this topic are to be found first of all in the interest, matured during my university years, in the vast banking sector. This fascination grew during my internship, which gave me the opportunity to come into contact with large Italian banks and allowed me to fully understand the fundamental mechanisms that characterise this reality. Owing to this interesting experience, I have decided to write my essay on the basis of the project undertaken during my traineeship.

The purpose of the following work is to illustrate the investigation carried out by Deloitte, one of the world's leading consulting firms, as a support to the incorporation of two Italian banks, with the aim of fostering the proper implementation of credit portfolio management systems. In this context, after an in-depth study of the European regulations that dictate the cardinal principles of bank mergers in terms of risk, analyses were carried out to study the credit risk models adopted by the two institutions. The introduction of the Basel Accords, which regulate the banking segment, especially following the recent financial crisis, has increased the constraints on banks' lending process, thus making it

necessary to accurately assess customers in terms of risk. The present work, in this sense, will focus on the study of the main risk factors that influence the reserve capital that each banking institution must hold and will assess the comparability of the two banks taken into consideration both in qualitative and quantitative terms.

The paper is divided into three chapters, which will first focus on the theoretical and general concepts of credit risk and then into the specifics of the project to support a bank merger. In particular, the first chapter analyses the main points of the regulations governing bank merger processes from a credit risk perspective. In this regard, mention can be made of the Basel Accords - along with their evolution during the last decades - which have contributed to highlight the fragility of the global banking system. The second chapter will deal with credit risk and its determinants with a brief divergence on the importance of risk management in recent years. Finally, the analyses on a specific case of incorporation are then presented in the third chapter, including the assessment of the credit risk models adopted by the two institutions and of the expected impacts on the different credit portfolios in the post-acquisition scenario, through the employment of statistical models.

2) Basel Accords

The Basel Accords are an organic set of shared rules and guidelines about bank capital requirements, whose aim is to improve the stability of the global financial system. They were created to respond to the need for a uniform regulatory framework about bank capital adequacy. As a matter of fact, the risk associated with the downturn of international financial markets in the 1970s and 1980s was that of an independent and heterogeneous adoption of more flexible rules on capital requirements among various countries.

The regulation known as Basel I was adopted in 1988 after the publication of a number of proposals drawn up over several years and followed by a consultative process in the G-10 countries. This was followed by the Basel II Accord of 1996 in which stricter safety measures for banks were implemented, introducing concepts such as bank ratings and minimum capital requirements. However, numerous unexpected shortcomings made it necessary to review and modify the content of the Agreements through the so-called Basel III Agreements of 2011. The long series of new regulations were introduced by the Basel Committee on Banking Supervision (BCBS), an international organization that works with the Bank for International Settlements. It was initially called the "Cooke Committee" after Peter Cooke, Governor of the Bank of England, who was one of the first to propose its creation and its first chairman. The foundation of the Basel Committee rests upon the need to promote closer cooperation among banks from different countries in order to preserve financial and monetary stability. Furthermore, it aims at strengthening the reliability and security of the international financial system and pursues the establishment of a standard in prudential supervision.

The Committee is headquartered in Basel where it meets four times a year to oversee banking activities around the world. The critical event that brought to the creation of the Committee is identified as being the failure of the German Bankhaus Herstatt, whose bankruptcy had major international consequences that forced the Bundesbank to put the bank into liquidation in 1974. It is important to specify that the Basel Committee has no regulatory powers. In fact, the adhering countries implicitly accept and make themselves bearers of the agreements reached during the meetings and, consequently, the agreement reached becomes a regulatory standard. Currently, countries such as Italy, France, Germany, Belgium, Canada, Japan, Spain, Switzerland, Luxembourg, the Netherlands, Sweden, the United States and the United Kingdom as well as 14 other countries around the world are members of BCBS.

2.1) Basel I Accord

The 1988 Basel Accords, referred to as Basel I, presented for the first time the concept of capital adequacy and regulatory capital, which requires a bank of any size to hold buffer capital commensurate with its risk exposure. This means that the more the bank lends to high-risk clients, the higher the percentage of capital it must hold. Therefore, a solvency ratio is introduced, according to which the ratio of a bank's regulatory capital to total credit risk-weighted assets must not fall below 8%.

$$Risk Asset Ratio = \frac{RC}{\sum RWAi} \ge 8\%$$
(1)

- RC: Regulatory Capital;
- Ai: *i-th* activity;
- RWA*i*: Risk weighting of the *i-th* asset.

Regulatory capital is given by the sum of two components, which are Tier 1 capital and Tier 2 capital, and includes all the elements of primary quality such as reserves, profit and paid-up capital to which hybrid capitalization instruments and capital gains are added. As far as the total risk-weighted assets at the denominator is concerned, it is obtained by multiplying the nominal value of all the assets by a weighting coefficient, which defines their relative weight. According to the Basel Accords of 1988, the choice of the weighting coefficient (0%, 20%, 50% or 100%), had to be based on the type of debtor and the riskiness of the country in which the debtor operated. For this reason, four distinct categories are introduced:

- Zero risk (weighting 0%), which includes cash and assimilated values, receivables from OECD¹ central banks and government securities issued by the governments of OECD countries.
- 2. Minimal risk (weighting 20%), which includes receivables from multilateral banks and receivables from public entities.
- 3. Medium risk (weighting 50%), which includes mortgages backed by collateral.
- Full risk (weighting 100%), which includes receivables from private companies, participations in private companies and receivables from banks and governments of non-OECD countries.

Table 2.1 below provides a summary of the categories to which the various weightings are associated.

	Zero Risk 0%	N	Ainimal Risk 20%	N	1edium Risk 50%		Full Risk 100%
•	Cash Due from Central Banks and governments of OECD countries Government bond issued by governments of	•	Due from multilateral development banks Due from banks in OECD countries Due from public	•	Mortgage loans on residential properties Facility for the issue of securities	•	Receivables due from private companies Equity investments in private companies Due from central banks and governments of non-
	OECD countries		sector entities			•	OECD countries Plant and other fixed investments

Table 2.1 - The four risk categories associated with the different securities

To give a practical example of the use of these new concepts, consider a loan made by a bank on a residential mortgage, with a face value of $\in 100,000$. In order to establish the

¹ Organization for Economic Cooperation and Development. Entered into force on September 30, 1961, it consists of 37 member countries and promotes, on a global level, policies that improve the economic and social well-being of citizens, through the integration of markets and the realization of the highest levels of economic growth and sustainable employment.

amount of capital that the bank must retain to grant the loan, it is necessary to calculate the various factors that make up the risk weighted assets. As mentioned previously, this is obtained by multiplying the value of the asset (in our case the loan with a face value of \in 100,000) by the coefficient established by the norm. As it can be seen from the table above, mortgage loans have a weighting coefficient of 50% and therefore our weighted asset value is equal to €50,000. From here, we can then define the amount of capital, or better, the regulatory capital that the bank must hold. In fact, multiplying the value of the weighted assets (€50,000) by the minimum coefficient established by Basel I (8%) we obtain a value of €4,000. However, if we look at the overall portfolio of medium-large banks, with loans reaching values close to one billion euros and with a consequent value at risk of hundreds of millions of euros, it is logical to think that this constituted a constraint on the expansion of risky assets, which therefore rewarded large banks and damaged small ones, with little capital available. Even though there were some shortcomings in Basel I, it cannot be denied that important results have been achieved from a regulatory point of view. In the first place, international cooperation between the various countries and banks has laid the foundations for the creation of a more cohesive global financial system, capable of defining homogeneous international regulatory standards.

2.2) Basel I limits

Although the Basel I Agreements were the starting point for deeper banking regulation, they had numerous limitations, among which the low sensitivity of the weighting coefficient to actual risk. In fact, by enclosing within the same risk category companies or banks that differed considerably from one another, thus not distinguishing them from a financial and economic point of view, it could happen that private companies that were riskier than others held the same weighting. All of this aggravated the financial situation of the lending banks, which saw their regulatory capital reserves steadily increase with the resulting tax burden. In this way, banks had an incentive to find different methods of offering services without having to excessively increase their capital reserves. Mention can be made of the use of securitizations² and other financial engineering instruments that transformed items on the balance sheet into items off the balance sheet without modifying the risk profile.

A final consideration can be made regarding the type of risk that was taken into consideration when estimating regulatory capital. Credit risk was, indeed, the only one considered, excluding market and operational risks. This great limit was then studied and re-evaluated in the 1999 Basel Accords, in which these two additional types of risk were introduced for the first time.

In conclusion, what made the Basel I Accords inadequate most of all was the complete lack of qualitative assessment of funding. The so-called "moral hazard" was precisely the tactic used by most of the large financial institutions to prefer riskier and therefore more remunerative financing as opposed to safe and higher quality financing but with obviously lower remuneration. All of this meant that, in the years following approval, the Committee met several times to evaluate possible improvements and adjustments to be implemented, and in 1996 began the drafting of Basel II Accords.

2.3) Main changes introduced in Basel II

In 1996, the Basel Committee began consultations for the drafting of a new proposal, defined as Basel II, which officially came into force in 2007, even though it had been in operation for many years. The main innovations introduced are not very different from those of the previous agreement, but nonetheless they aimed at a more complete and precise definition of the standards that banks and financial institutions of member countries had to comply with. In fact, just as in Basel I, banks would have to set aside capital reserves proportional to the risk arising from the various loans granted, but with the introduction of an important innovation: the concept of rating. If up to that moment it was the specialized agencies that issued the various ratings, since the entry into force of the new agreements there was the possibility for banks to develop their own internal rating tools, without the need for external consultancy, allowing banks to have a more concrete

 $^{^2}$ Securitizations are complex financial transactions, characterized by the presence of several legal transactions linked to each other, through which portfolios of receivables are selected and aggregated to constitute a financial support to guarantee securities which are then placed on the capital market.

and realistic view of the various risks. Therefore, it was essential for companies to operate as efficiently and transparently as possible, optimizing processes and strengthening their image in order to pass the "checks" of bank ratings.

In 1999, the Basel Committee published the first consultative document for the revision of the 1988 agreement in which the three-pillar approach was outlined:

- the first pillar concerned the new rules on the calculation of weighting ratios and, in particular, on minimum capital requirements. This principle established the percentage of minimum capital that had to be held by the banks, not only in relation to credit risk but also to operational and market risks;
- the second pillar related to the monitoring and supervisory activities of the Supervisory Authorities. It was then established that prudential control, based on the assumption that compliance with a certain standard of capital and certain balance sheet ratios can reduce the risk and cost of insolvency, was to be carried out by the Supervisory Authorities;
- the third pillar defined transparency and market discipline, i.e., the minimum levels of information that each bank had to provide to the market regarding regulatory capital, risk exposure, risk assessment processes and scope of application.

2.3.1) Pillar I. "Minimum Capital Requirements"

The first pillar, as mentioned earlier, refers to minimum capital requirements. Despite the many changes, both the definition of regulatory capital and the minimum solvency ratio requirement (8% of risk-weighted assets) have remained unchanged. The main change concerns the introduction, for the calculation of regulatory capital, of two types of risk, namely market risk and operational risk. The formula for determining regulatory capital is thus extended:

$$\frac{RC}{RWA (Credit Risk) + RWA (Market Risk) + RWA (Op. Risk)} \ge 8\%$$
(2)

On the other hand, the new agreement radically modified the risk assessment methodology, offering the choice between two different approaches. The simplest one, defined as the standardized approach, follows the Basel I methodology but allows for the use of external ratings to grant a more articulated risk assessment and therefore a greater variety of weightings; the most complex approach, based on the development of internal ratings, enables the use of the bank's non-public information assets to determine a more effective correspondence between capital and risk. The risk categories that a bank must consider against regulatory capital are:

- Credit risk, resulting from the granting of loans to third parties, is a component of all lending activities and, as such, affects the investment choices of banks, financial intermediaries and bond investors.
- Operational risk, i.e. the risk of losses arising from the inadequacy or dysfunction of procedures, human resources and internal systems, or from exogenous events.
- Market risk, defined as the risk produced by unforeseen events that impact the value of assets and therefore losses in on- and off-balance sheet positions as a result of unfavourable changes in market prices.

Focusing on credit risk, which will be discussed in the next chapter, this can be considered the most impactful for businesses, being the other risks more general and pertaining to the normal course of economic activity. In order to identify the underlying difference compared to the previous agreements, consider a bank granting a loan of $\notin 100,000$ to two types of companies, one more risky and the other less so. While the old agreement provided for a weighting coefficient of 100% equal for both, the weight is now assigned based on riskiness resulting in the former being 50% and the latter being 150%. Consequently, the capital to be set aside will correspond to $\notin 4,000$ for the less risky company (= 8% * $\notin 100,000$ * 50%) and $\notin 12,000$ for the riskier one (= 8% * $\notin 100,000$ * 150%). Consequently, a bank will tend to reward the best firm between the two, as the bank's capital provision to cover possible credit losses will be lower.

2.3.2) Pillar II. "Supervisory Review"

The second pillar refers to the supervision and monitoring activities of the Supervisory Authorities regarding the adequacy of the banks' capital. The aim of the supervision activity is to provide an overall assessment of the work of the various banks, encouraging them to use effective and transparent risk assessment techniques. Specifically, this monitoring activity has the merit of maintaining continuous contact between authorities and banks, encouraging the latter to improve and optimize their risk assessment processes. Indeed, banks are required to carefully assess the adequacy of internal capital to cover all the risks they may potentially face during their operations.

The functions that the supervisory authority is required to perform are briefly identified as follows:

- Internal Capital Adequacy Assessment Process (ICAAP): a bank must conduct periodic assessments of the adequacy of internal capital based on its risk profile and determine a strategy to maintain the required level of capital.
- Supervisory Review and Evaluation Process (SREP): supervisors are required to review and evaluate banks' internal capital adequacy assessments and strategies, as well as their ability to monitor compliance with regulatory capital ratios.
- Ensure that banks maintain their capital structure by intervening in day-to-day decision-making to prevent capital from falling below the minimum level.

2.3.3) Pillar III. "Market Discipline"

The last pillar, which regulates market discipline, includes the introduction of an obligation for banks to inform the public about their capital adequacy in relation to risks so as to make their work completely transparent and to reward those institutions that implement sound principles of risk assessment and penalize those that venture excessively risky investments. Specifically, a system is being introduced to tighten up the level of control over the information provided by individual banks, such as the type of financing implemented, the adequacy of capital and the fulfilment of the minimum requirements imposed. In this sense, banks are required to make publicly available information on capital allocation techniques and the risk control and management

process, such as methodologies and processes, guaranteeing greater security and market solidity.

2.4) Credit risk measurement

The most prominent innovation in the Basel II agreements was the establishment of a correlation between the capital required and the level of credit risk of each individual position. A key aspect, therefore, will be determining the riskiness of each individual loan, which is now possible using two distinct types of approach:

- Standardized approach, through which banks operating mainly in non-complex credit activities and having simplified control systems can rely for measurements of capital requirements external to the bank itself, owing to the aid of specialized agencies such as Moody's and Standard & Poor. However, it follows from this methodology that banks do not have a realistic and complete view of their own clients and base their assessments solely on data from other institutions.
- Internal Ratings Based (IRB): in this case, banks develop their own procedure for evaluating and measuring risk based on a set of requirements regarding the data used, the calculation models and operational functionality. The fundamental part of this system is the rating model: in fact, banks must scrupulously calculate the probability of default of the beneficiaries so as to place them in one of the categories that make up the rating scale. The relevant factors in this context concern both quantitative and qualitative analyses, based mainly on multiple regression statistical models. The application of the system can be done through a basic approach (FIRB) or an advanced approach (AIRB), which differ mainly in the type of parameters used.

2.4.1) The Standardized Approach

The standardized approach refers to a set of risk measurement techniques, mainly used by smaller banks. In this case, the risk-weighted value of the exposures is assigned directly by external rating agencies i.e., Moody's, Fitch Ratings, Standard & Poor, which must meet a series of requirements, including transparency and uniformity of the criteria adopted, as set out in the second pillar. The rating values assigned to the various counterparties which, when multiplied by the exposure value, make up the RWA, depend not only on the type of counterparty itself, but also on the relative credit quality, the possible presence of risk mitigation techniques and the exposure at the time of default.

Table 2.2 below defines the various categories on which the risk assessment depends.

	Probability that the counterparty will default on its obligation						
Probability of	to repay the loaned principal and related interest, whose						
Default	weighting is assigned based on external ratings.						
	Algorithms and parameters for valuing collateral and persons						
Risk Mitigation	provided by supervisors.						
Exposure at time	Expected amount of loss a bank faces in the event of						
of insolvency	counterparty default, as estimated by supervisors.						

Table 2.2 - Parameters influencing the choice of risk weighting

The four macro-categories into which the different counterparties are divided are:

- Sovereign States and Central Banks.
- Banks, with a further subdivision regarding the duration of the credit.
- Companies (Corporate), whose weighting coefficient can vary from 20% to 150% based on the overall risk assumed.
- Retail, which also includes small businesses, with turnover of less than 5 million and exposure of less than 1 million, which are assigned a weighting coefficient of 75%.

This methodology has a greater impact on sovereign debtors and banks, which possess a defined rating, while it has a limited effect on the debts of companies that do not have an external rating. *Table 2.3* provides an overview of the new calculation coefficients for risk-weighted assets.

	AAA to AA-	A+ to A-	BBB+ to BBB-	BB+ to BB-	B+ to B-	Below B-	Unrated
Sovereign States	0 %	50%	50%	100%	100%	150%	100%
Banks	20%	50%	50%	100%	100%	150%	100%
Companies (Corporate)	20%	50%	100%	100%	150%	150%	100%
Retail	75%						
Mortgages and 35%							
Commercial Mortgages	From 50% to 100%						

Table 2.3 - All the different risk weights in relation to counterparties and degree of riskiness

2.4.2) The IRB Foundation (FIRB) and IRB Advanced (AIRB) Approach

IRB approaches are based on internal rating systems and are only pursued by large banks due to the complexity of use and study. In particular, they allow a classification of creditworthiness based on the customer's riskiness and probability of default. The two methods that have been classified in the Basel II agreements are the IRB Foundation approach (FIRB), based primarily on the use of analytical tools that allow the calculation of the probability of default (PD) besides directly relating the bank and the client, and the more sophisticated IRB Advanced approach (AIRB), calculating two other distinct factors such as loss given default (LGD) and exposure at default (EAD) as well as Maturity.

Specifically, the main differences with the standardized approach are the use of the following parameters:

• Probability of default (PD), or default rate, defined as the probability that the counterparty will default on its obligation to repay the principal loaned and the interest accrued on it.

- Loss given default (LGD), the amount of money a financial institution loses when a borrower defaults on a loan, after taking into consideration any recovery, represented as a percentage of total exposure at the time of loss.
- Exposure at default (EAD), or the measure of exposure risk, which estimates the actual value of the loan when default occurs.
- Maturity (M) or maturity of exposures, which will be equal to 2.5 years for banks adopting the basic FIRB method.

Clearly, the use of these alternative methods must be subject to the judgement of the Supervisory Authority, which must verify their operativeness and correctness through a series of organizational and quantitative criteria. In this sense, one of the prerequisites decided by the Basel Committee to be able to use the IRB methods consists in the adoption and internal use of the estimation models for at least three years.

For the purposes of synthesis, *Figure 2.1* below plots the percentage of exposure required to be held as capital and the various rating categories following both approaches used in the first Basel I agreements and the two methods envisaged by Basel II. As it can be seen, while in Basel I the percentage of 8% remained fixed for any type of exposure, now with the introduction of the standardized method and the IRB method there is an increasing demand for safety capital as the rating decreases.



Figure 2.1 - Chart plotting the percentage of exposure required to be held as capital with the three approaches used (Source: Liando, 2005)

2.5) Basel II limits

The problematic aspects of the Basel II accords lay mainly in the difficulty for banks to collect the data and information needed to use the risk measurement tools. The main cause was the quality and level of capital owing to the presence of an excessive number of hybrid capital instruments, including capitalization instruments that can be issued by banks in the form of bonds and certificates of deposit redeemable to subscribers at the request of the issuer. Another major problem was financial pro-cyclicality³, which saw banks unable to cover the risks associated with economic downturns despite accumulating reserves during periods of expansion. This is followed by the strong uncontrolled increase in financial leverage⁴: this phenomenon led banks, in crisis situations, to drastically reduce loans to clients, resigning many assets to repay debts, creating negative effects on the real economy. As a matter of fact, leveraging allows an individual to buy or sell financial assets for an amount greater than the capital held, consequently benefitting from a potential return greater than that resulting from a direct investment in the underlying while conversely increasing the exposure to the risk of very significant losses.

Finally, the last consequence was that all the methods provided by Basel II and above all by the IRB advanced, were within the reach of only the largest institutions, defining a discriminant between medium-small and large banks. Indeed, those who could afford large costs to carry out very accurate analysis, namely larger banks, could obtain more information on the company to which they were lending money, greatly reducing the risk and consequently the amount of safety capital to be held.

2.6) The 2008 financial crisis

A financial crisis, in economics and precisely in a macroeconomic context, occurs when the demand for money, in the form of capital by companies, is greater than the supply by banks and investors. Looking at the past 120 years, banking crisis have lasted

³ Pro-cyclicality consists in the technique of adapting to fluctuations in the economic cycle, accumulating money in periods of expansion to cover losses in periods of recession.

⁴ Debt ratio, defined as the ratio of debt to equity (capital and equity reserves) of a company.

on average for 2-3 years and cost 5-10% of GDP, affecting almost all countries in the world. Most financial crisis in advanced economies follow a relatively similar pattern that starts from a credit boom, often due to financial liberalization or technological innovation, leading credit in the economy to grow rapidly and asset price bubbles to form.

Following some initial adverse shocks, the economy enters in a crisis period that can be classified in several stages:

- Initiation: in this stage the lending asset bubble ends; as a result, loans' values fall and banks reduce their liabilities by cutting back on lending (develeraging). Therefore, the economy experiences a credit freeze and interest rate rise reducing the cash flow of firms.
- Banking crisis: during this stage, economic activities decline, liquidity evaporates and some banks fail.
- Debt deflation: in this stage price levels decline and consumption stalls (deflationary spiral⁵).

Figure 2.2 represents the frequency of financial crisis around the world over the past 120 years.



Frequency of financial crises around the world

Figure 2.2 - Chart plotting the percentage of countries experiencing financial crisis over the last 120 years (Source: G. Gorton/ AR Financial Economics 2018 - Knowable magazine)

⁵ A deflationary spiral is a downward price reaction to an economic crisis leading to lower production and consequently lower prices.

Similarly to most financial crisis, the one of 2008 has its roots in the economic boom of the preceding years, characterized by favourable global financial conditions with massive inflows of funds from EM (Emerging Markets) economies, assuming the shape of a rapidly growing current account deficit and a record-low interest rates for an extended period of time. A prominently important factor in this context was securitization: banks repackaged loans, especially mortgages, and then resold them, thus freeing up capital for new loans. This process was widely perceived as a positive development, as it allowed for a better and wider distribution of risk, encouraging risk-taking not only within but also outside the financial sector.

To give a clearer idea of this, *Figure 2.3* offers an insight in the trends regarding subprime⁶ volume in the years immediately prior to 2008.



Figure 2.3 - The volume and the shares of subprime in the 15 years preceding the crisis (Source: Inside Mortgage Finance)

As the chart above illustrates, the origins lie in the vertiginous growth of the real estate market in the United States, which created a speculative bubble that caused a real explosion in the value of mortgages, amplified by the fact that the same banks that granted them not only did not take on the risks but passed them on to third parties through various

⁶ Subprime refers to loans that are granted to a person who cannot access market interest rates because he has had previous problems in his borrowing history.

financial instruments such as CDSs⁷. The first to pay the consequences were the large American credit institutions such as Lehman Brothers, which collapsed on September 15, 2008. In a short time, the crisis spread to the entire global financial system, drastically reducing the population's ability to consume and save, with recessive effects on the economy.

Figure 2.4 shows the percentage change in GDP in the Eurozone and in the US during the crisis period.



Figure 2.4 - Variation of GDP in the Eurozone and in the US during the crisis (Source: KBC Economic Research based on: OECD)

2.7) From the financial crisis to Basel III

The 2008 financial crisis highlighted the criticality and vulnerability of the large international banking system, which was now too exposed to risks of insolvency and instability. Even though the Basel II agreements had profoundly modified and improved many of the regulations in the area of risk management, the Great Recession revealed numerous shortcomings, first and foremost the inability of banks to absorb shocks deriving from financial and economic tensions. For this reason, in 2011 a set of rules known as Basel III was launched, laying the foundations for a complete restructuring of

⁷ CDS, or Credit Default Swap, is a swap contract between two parties that offers the possibility of hedging against the possible default of a debtor against the payment of a periodic premium.

the banking regulatory system, creating a regulatory asset capable of radically changing the way banks operate and their profitability.

One of the most important aspects is undoubtedly the introduction of the concept of capital quality. The primary objective of the new agreements was precisely that of increasing the capacity of banks to absorb losses, and for this reason Tier 1 capital, destined to cover losses in the case of continuous business activity of the company, went from 4% to 6% of RWA, while Tier 2 capital, destined to cover losses in the case of a financial crisis, covered 2%. As a consequence, greater emphasis was placed on ordinary shares and profit reserves (common equity), whose requirement has been raised to 4.5% of risk-weighted assets, as shown by *Figure 2.5* below.



Figure 2.5 - Level of minimum capital requirements and buffers (Source: brainstudy.info)

A new element can be traced back to the introduction of real buffers, whose main purpose is to act as a shield in periods of crisis and market tensions. In particular, capital preservation buffers and countercyclical capital buffers are mentioned. As far as the former is concerned, it was introduced mainly to cope with periods of high tension in the market, allowing the bank to possess more liquidity. As *Figure 2.5* illustrates, the capital preservation buffer (made up of common equity) requires an additional 2.5% of riskweighted assets to be held, raising the common equity requirement to 7%. On the other hand, the countercyclical buffer is one of the most interesting innovations because it allows banks to accumulate higher capital reserves during periods of market expansion in order to deal with any excessive growth in credit which has as its immediate consequence an increase in systemic risk.

A new element, imposed by the Basel Committee to deal with the financial crisis of 2008 and to ensure that it could not be repeated in the future, was the leverage ratio, i.e. a minimum requirement of 3% of the ratio of assets to equity aimed at reducing the excessive indebtedness of banks due to the recent popularity of leveraged investments enabling to have significantly high but also very risky returns.

The formula for measuring the leverage ratio is as follows:

Lev. Ratio =
$$\frac{\text{Tier 1}}{\text{Unweighted Uses + Off balance sheet actvities}} \ge 3\%$$
 (3)

In addition, two liquidity indicators are introduced:

• Liquidity Coverage Ratio (LCR), defined as the proportion of highly liquid assets held by financial institutions to ensure their continued ability to meet short-term obligations.

$$LCR = \frac{Stock \ of \ high \ quality \ liquid \ assets}{Tot. \ net \ cash \ out \ flows \ over \ the \ next \ 30 \ days} \ge 100\%$$
(4)

This new indicator requires banks to hold high-quality liquid assets with high ratings and low volatility.

• Net Stable Funding Ratio (NSFR), that is a liquidity standard requiring banks to hold enough stable funding to cover the duration of their long-term assets. It is defined as the ratio of the available amount of stable funding to the required amount of stable funding. The term "stable funding" refers to the amount of capital at risk and contracted debts, which are considered to be reliable sources for a bank in the event of a prolonged phase of distress.

$$NSFR = \frac{Available \ source \ of \ stable \ funding}{Required \ source \ of \ stable \ funding} \ge 100\%$$
(5)

The available source of stable funding includes preferred stock, bank's capitals and liabilities with maturities greater than one year.

To conclude, in the Basel III agreements primary importance is given to securitizations, one of the many factors that caused the 2008 crisis. In particular, this new regulation compels banks to assess the creditworthiness of externally rated securitization positions carefully and precisely, ensuring that the first guarantor of the risk of losses would be the intermediary. It is no coincidence that the implementation of the Basel III agreements led to a major wave of criticism from the world's leading financial institutions, owing to the fact that banks needed to refuse excessively risky investments implying the requirement of large amounts of capital to be held. In the long term, the repercussions on the world economy would enable only high-rating (AAA) companies to access the credit system while lower rating ones would have to deal with interest rates that are too high or even to exit the financial system. In this regard, in an article published by Il Sole 24 Ore, the former European Central Bank President Mario Draghi, distinguishes two categories of banks, those of series A, namely the so-called "too big to fail" and those of series B that will be denied credit for excessive riskiness.

Despite the contrasting opinions about the new reforms and the long transition periods, which have highlighted some problems in the long term, it cannot be denied that this new set of regulations has improved and made the global financial system much more efficient, creating the conditions for a more stable and cohesive economy, capable of facing new and increasingly complex challenges with the right tools.

3) Credit risk

Credit risk is defined as the risk that, within the framework of a credit transaction, the debtor does not fulfil the payment of interest to his creditor and his obligation to repay the principal. Referring to a granting of loans, thus to a disbursement of financial resources, the bank holds the right to claim the repayment of the capital with the consequent payment of interest and therefore can take the liberty of carrying out all the necessary analyses with regard to the counterpart. The failure to repay loans, especially on a large scale, could lead to negative consequences, both in terms of profitability and finance, which can lead to an increase in business risks and a decrease in the value of the assets represented by the loans. Hence, the decrease in the quality of the loans granted determines a real and concrete problem, which must be dealt with through an adequate diversification of portfolios and a careful and accurate evaluation of the customers entrusted. It is precisely for this reason that in recent years credit risk management has become fundamental to the progress of financial institutions. From a bank's point of view, risk prevention not only leads to an increase in the quality of debtors but also to more "safe" capital being invested. All this can take place both through targeted interventions on individual exposures, reducing the extent of losses, and on the overall structure of credit portfolios, diversifying risk and allocating credit between distinct and unrelated counterparties.

Although credit risk management cannot eliminate the risks embedded in lending activities, the primary objective shall be to provide an estimate of the risk as accurately as possible in individual lending transactions and in the overall structure of the credit portfolio. In particular, a good credit risk management model should give a correct estimate of the losses that could occur, specifying the probabilities associated with the various loss forecasts. The model should also take into account the amount of money that is expected to be lost on that portfolio (expected loss) and the maximum level of losses that could occur within a given confidence level (for example, 99% of the time). However, for this to be a true risk, an unforeseeable component must also be introduced, namely an unexpected change in the credit position. As a matter of fact, the real component of credit risk is not represented by the expected loss, which is already accounted for and included in the costs, but rather by the possibility that, despite the

valuations made being close to reality, an unanticipated and unpredictable deterioration in the creditworthiness of the counterparty may occur (unexpected loss).

A further element to be considered in the management of credit risks is that, among the financial instruments subject to these risks and in addition to classic debt securities such as treasury bonds⁸ and corporate bonds⁹, there are also some off-balance sheet positions. These include derivative securities traded on regulated markets as well as derivative securities traded on over the counter¹⁰ markets for which there is counterparty risk and credit derivatives.

In general, like all other types of risk, credit risk is influenced by the economic cycle, decreasing in periods of economic growth and increasing in periods of recession. In addition to this, being a category of risk that depends primarily on the economic behaviour of the various debtors, it could happen that if the latter do not adhere to their pre-established commitments, their assigned rating could be reduced (downgrading¹¹), with a consequent increase in interest rates. Of course, any type of bond considered less safe will have a higher yield than a bond with a higher rating, precisely because investors are willing to assume a high risk in exchange for a high yield.

3.1) The components of credit risk

With reference to what has already been mentioned in the previous section, the main components that come into play when calculating credit risk are the expected loss and the unexpected loss, which in turn consist of a series of parameters, including the probability of default, the exposure at default and the loss given default. The combination of these factors, which we will analyse in detail in the following paragraphs, has the fundamental objective of confronting the credit institution with the amount of money that it will have to set aside and expect to lose by lending a certain amount of capital to a counterparty.

⁸ Treasury Bonds are government debt securities with maturities greater than 10 years from the date of issue.

⁹ A corporate bond is a type of debt security that is issued by a firm and sold to investors.

¹⁰ Over-the-counter markets are markets that don't meet the requirements of the regulated markets.

¹¹ The downgrading is defined as a revision of the level of credit quality of a given financial instrument.

The term "expected loss" refers to the average value of the distribution of loss rates that a lending institution expects to incur on a portfolio of loans. As the name implies, it is possible to predict the value of this component by means of a linear combination of several factors, which can be calculated analytically and are consequently already included in the costs of the credit institution.

On the other hand, greater challenges are posed by the unexpected rate of loss, i.e., the risk that the loss will prove to be greater than initially expected, which is affected by a greater or lesser degree of variability and thus cannot be certain. This is the most critical component of credit risk as it cannot be eliminated completely but only mitigated through careful portfolio diversification. As we shall evaluate in the following paragraphs, the variability of the unexpected loss decreases as the degree of correlation of the individual loans decreases.

Expected loss and unexpected loss are only two of the many components that determine the credit risk of a counterparty. Listed below are the other variables that come into play when discussing credit risk:

- Exposure risk, defined as the amount of a credit facility that results at the time of default. Since no credit is granted without risk, the exposure is identified with the risk of loss of the money invested and, since it has a random value, it can differ considerably from the calculated value.
- Concentration risk, defined as the risk considered when a loan is granted mainly to the same person or to groups of persons belonging to the same business sector. In this case, the risk originates from the possibility of major fluctuations in relation to the calculated value, leading to a loss of all assets at once.
- Migration risk or downgrading: this is the risk related to the debtor's creditworthiness deterioration, leading the counterparty to downgrade its rating. The immediate consequence of this process is an increase in the riskiness of the counterparty, followed implicitly by a lowering of quality and a rise in interest rates.
- Spread risk, defined as the probability that the spread will increase, given the same rating and creditworthiness, and consequently the risk premium demanded by the markets on capital.

- Recovery risk, identified as the risk that the recovery rate that was initially expected, in the face of a default, is lower and therefore leads to a greater loss.
- Country risk, defined as the risk of interruption of loan payments by foreign borrowers, i.e., a risk of default by a foreign government on loans issued by the same government.

It should be noted that all this long series of risks, although requiring consideration when calculating the various costs, will hardly be found in all its facets since the analyses and research that credit institutions have been carrying out lately lead to an accuracy close to 100%.

3.1.1) The probability of default (PD)

The first component influencing the expected loss and the capital that must be set aside by lending institutions is the probability of default or insolvency (PD), represented as the probability that the counterparty will default on its obligation to repay the principal and interest. This probability can be estimated either by specialized rating agencies, through a grade ranging from AAA for the most deserving companies to D for the riskiest companies, or through internal models that the bank itself builds from within.

Bond ratings are judgements about firms' financial and business prospects and for this reason there is not a fixed formula to calculate them. However, when banks need to analyse the profile of a particular bond in order to assign it a rating, they look at a few ratios, such as operating margin and interest cover. *Table 3.1* illustrates how financial ratios differ according to a firm's bond rating (Moody's Financial Metrics). In this regard, all bonds listed below Baa are defined as high yield or junk bonds¹².

¹² Junk bonds are bonds issued by companies with a high risk of default and which incorporate a high expected yield.

Ratio (%)	Aaa	Aa	A	Baa	Ва
Operating margin	21,6	21,1	14,5	12,5	11
Debt Ratio	30,8	50,8	43,7	50	53,9
Interest Cover	21,2	12,3	8,1	4,5	3,2

Table 3.1 - Indices of measurement of a company in relation to the various bond ratings

What emerges from the table above is the presence of a real correlation between certain indices measuring a company and their rating. For instance, an increase in indices such as the operating margin or the interest cover corresponds to an increase in the rating grade. In this context, even though there is no real definition of default yet, as everyone adapts it to his or her own favour, it is possible to identify two types of calculation for PD.

First, there is the estimation by means of complex statistical models, known as scoring, through which the different companies are given a score weighted by a series of financial indices concerning company performance. This approach can be used for narrow segments, such as Retail, while it would be too complicated to put into practice for Corporate clients.

Another type of approach, which was mentioned in the previous section, concerns a subjective estimation of the various probabilities of default of the debtor, implemented by expert rating agencies, that yet may lead to results that are inaccurate, since they are subjective. Both methodologies need to be grounded and therefore the choice of values will be influenced by factors both specific to the investment and to the borrower. In particular, attention should be paid to the sector and country in which the debtor operates, mainly because, at the moment of insolvency, a series of legal procedures will be triggered, which may vary from country to country and can lead to significant differences in terms of timing. In addition to this, the focus should shift to the real internal variables of the investment, i.e., the possible presence of real assets to guarantee the credit and the type of litigation expected for recovery.

The graph below displays the probability of default in relation to loan age (Figure 3.1).



Figure 3.1 - Chart plotting the probability of default and the loan age (Source: A causal framework for credit default theory, Sy, 2007)

As shown in the graph above, one of the factors influencing the probability of default is the length and age of the loan, delineating an increasing proportional relationship. This fact can be briefly explained by comparing a one-year loan with a ten-year loan. It is logical to expect that a borrower is more likely to repay his debt if it is one year rather than ten years because of the nature of the investment and the provision of the bank, which will be much more reliable in the short term than in the long term.

3.1.2) Loss Given Default (LGD)

Loss given default is the amount that a credit institution would lose in case the counterparty was to default, depicted as a percentage of total exposure at the time of default. Since this is also an estimate, it may be studied and approximated internally by individual banks or dictated directly by the supervisory authorities based on the characteristics of the credit.

For example, with respect to those banks that use the FIRB approach (*see Chapter 2.4.2*), the rules used are standardized and depend on the contractual characteristics. Specifically, these values will be:

• 75% of the credit in the case of subordinated transactions.

- 45% of the loan in the case of unsecured transactions.
- < 45% in the case of secured transactions and to an extent corresponding to the type of collateral collected.

The estimate would be different if the bank uses an AIRB approach (*see Chapter 2.4.2*). In this case, the LGD value to be applied to the different types of exposures, based on internal analyses, will be determined directly by the bank. These values will then need to be reviewed and verified by the supervisor authorities, which will allow their internal use. One of the first steps a bank must take in estimating LGD is an ex-post review of historical recovery rates to verify the effectiveness of each bank's recovery processes. Furthermore, LGD estimates must adopt a "long-run" perspective and therefore has to consider the average economic loss of all defaults, not only in relation to periods of economic growth but also to periods of recession.

As a variable that depends primarily on the nature of the financing and the collateral that backs it, the most important factors on which it depends are the degree of liquidity of the firm's assets, the severity of the default and whether collateral is in place.

The graph below, which plots the probability of default of different bonds against the required reserve capital, shows three types of curves, which vary as the LGD varies (*Figure 3.2*). In this case, the higher the estimated LGD, the higher the required capital required, which will also depend on the rating assigned to the bond.



Figure 3.2 - Percentage of required capital by bond type and LGD (Source: Exploring risk based pricing for corporate loans, Sen Nagarajan, 2014)

To understand how LGD is calculated in practical terms, consider a loan of \notin 500,000. Before the bank can grant the loan, it will have to carry out the necessary analysis regarding the customer's history, his arrears and his ability to repay the debt. Assuming that the bank decides to grant the loan, on the day the borrower defaults, the bank will become the owner of what the client has acquired with the loan. However, the value at which the bank will be able to sell it again will be lower than its historical value, i.e., \notin 350,000. From this, it is easy to see that the bank's loss will be \notin 500,000 - \notin 350,000 = \notin 150,000 and consequently the LGD will be equal to (\notin 150,000 / \notin 500,000) * 100 = 30%. Should such a scenario occur, the defaulted company has the possibility to repay its debt within the next 3 months or, alternatively, it is possible to recover the loan amount selling two types of assets: collateral assets and unpledged assets. The first refers to any property or asset that the company owns yet not mentioned as collateral at the time the contract was drafted.

As mentioned above, there is no single methodology for defining LGD. However, it is possible to summarise the two main approaches currently used by credit institutions and rating agencies, which are:

• Market Price Approach, whereby LGD can be calculated using the recovery rate, namely the ratio between the market value of the bond one month after default (MV) and the nominal value of the bond (NV).

$$LGD = 1 - \frac{MV}{NV} \tag{6}$$

This ratio is also known as Recovery Rate (RR), identified as the percentage that the bondholder recovers, relative to the nominal value of the bond, when the issuing company goes into default or bankruptcy.

 Actual Pay-outs Approach, whereby it is possible to estimate the amount of LGD through a combination of several variables, such as exposure at default and the amount of the value of claims recovered. The formula will be described as follows:
$$LGD = 1 - \frac{\sum_{1}^{N} \frac{ER}{(1+i)^{t}} - \sum_{1}^{N} \frac{AC}{(1+i)^{t}}}{EAD}$$
(7)

Where:

- \Rightarrow *ER* or *Expected Recovery* is the value of the recovered receivables depending on the intrinsic characteristics of the loan.
- \Rightarrow AC or Administrative Costs are all the administrative costs for the recovery of the credits to take place.
- \Rightarrow *EAD* or *Exposure at Default*, which we will discuss in the next paragraph, indicates the exposure at the time of default.
- \Rightarrow *t* is the time frame over which the loans are expected to be recovered.
- \Rightarrow *i* represents the interest rate for the transfer of funds.

In recent years, the calculation of LGD has become increasingly important and complex. Indeed, not only does an accurate assessment of this variable lead to higher borrower quality, but it also determines the amount of safety capital a bank must hold. As it is closely linked to expected loss and minimum capital requirements, even a small change in LGD could compromise the final analysis and significantly distort the result.

To get a clearer idea of how much influence a correct LGD calculation has, curve patterns in *Figure 3.3* below may be considered. The plot compares the main approaches used to calculate LGD in the risk weights - probability of default graph.



Figure 3.3 - Risk weight level related to the probability of default in four different versions (Source: Liando, 2005)

In the graph above, four curves are shown, each with a different characteristic from the others. For instance, the red and green curves referring to Basel I and Basel II respectively obtained using the standardized approach, are constant, as these agreements provided for a constant measure of risk weights regardless of the probability of default of the client. The IRB approach, on the other hand, shows that the curves increase proportionally as the probability of default and LGD increase, considerably varying the risk weight percentage.

3.1.3) Exposure at Default (EAD)

The Exposure at Default (EAD) is the amount of exposure that the bank will have to face when a particular client defaults. The loss depends on the amount the bank was exposed to the borrower at the time of default and is obtained through a combination of three variables: the Drawn Portion¹³ (DP), the Undrawn Portion (UP) and the percentage of the unused portion that is expected to be drawn down by the borrower at default (UGD). The EAD formula will be described as follows:

$$EAD = DP + UP * UGD \tag{8}$$

Suppose a bank grants an overdraft facility of $\notin 500,000$, assuming that the portion of the facility used is $\notin 300,000$ and the utilization in case of default is 60%. From this, the EAD can be estimated as $\notin 300,000 + \notin 200,000 * 60\% = \notin 420,000$.

Banks often calculate an EAD value for each loan and then use the figures to determine their overall default risk. It is a dynamic number that changes when a borrower repays a lender.

As with LGD, the calculation of EAD is done in two different ways in the case of internal risk models. Specifically, for the FIRB approach, the calculation is guided by regulators and takes into account the underlying asset, the type of structure and the details of the contract, without considering collateral and guarantees.

¹³ An overdraft is defined as a commitment by a bank to make a sum available to a client, or to assume on his behalf an obligation to a third party.

Under the AIRB approach, banks have greater flexibility to calculate EAD directly through internally developed statistical models, which must be reviewed by supervisors before implementation. In addition, all estimates of EAD must be calculated net of specific provisions in order to achieve accurate results.

3.1.4) Expected loss and unexpected loss

The term "expected loss" (EL) refers to the average value of the loss distribution that a bank expects to achieve on a loan portfolio, i.e., the cost to the bank for its credit exposure. The main characteristics of this variable are that it is recognized in the accounts, loaded into the pricing conditions, and that it can only be stabilized by increasing the volume and diversification of transactions.

The approach to this type of loss can be a financial one, which consists in considering it as the value of the loan, resulting from changes in the credit quality of the counterparty or, in the most extreme cases, from the loss in the event of default. In this case, it will be necessary to use mark-to-market¹⁴ or mark-to-model¹⁵ valuations, depending on whether the market provides reliable information or not.

The second method involves the implementation of the actuarial method, according to which the loss is the one incurred in the event of contractual default, i.e., the "damage" resulting from an adverse event. From this point of view, the expected loss represents a certain cost that a bank will incur by providing money to counterparties of a certain type.

From an analytical perspective, expected loss is defined as the product of the probability of defaults, loss given default and exposure at defaults.

$$EL = PD * LGD * EAD \tag{9}$$

A summary of the main components influencing the expected loss is shown in *Table 3.2* below.

¹⁴ Mark to market is the valuation method whereby the value of a financial instrument is systematically adjusted to reflect current market prices.

¹⁵ Mark to model is a pricing method for a position or portfolio at prices determined by financial models.





The expected loss, if estimated correctly, does not represent a true risk but rather a measure of the minimum spread that a credit institution should apply to the credit in order to have sufficient renumeration to cover the risk.

For instance, let us suppose that a bank, after appropriate checks and estimates of the values mentioned above, issues a loan for $\notin 500,000$ to a counterparty with a PD = 2%, LGD equal to 30% and an EAD equal to 90% of the initial credit (assuming that 10% of the credit has already been amortized). From this, it follows that the loss the bank must expect for this particular loan is EL = 2% * 30% * $\notin 450,000 = \notin 2,700$.

However, it is possible that in a period of economic growth there are no borrowers who default, but in a recession, there are more than expected, thus the value calculated is potentially not the only one. As a consequence, a bank's ability to foresee the necessary provisions plays a fundamental role. Indeed, if the bank does not take care of such a prospect, in a recessionary year there may be insufficient reserves to meet the losses recorded in the profit and loss account, and the bank may itself experience a crisis.

This occurrence is called "unexpected loss", which represents the degree of volatility of the loss rate around its expected value, i.e., the possibility that the average loss value is higher than previously estimated. Unlike the expected loss, which, as the name implies, can be predicted, this factor is unforeseeable and cannot be accounted for. It has to be covered by the assets themselves and can only be dealt with by careful portfolio diversification. The main element on which it depends is essentially the degree of dispersion of possible loss rates. In other words, a correct method for assessing the degree of variability of loss rates around their expected value can be the standard deviation, such that the greater the unexpected loss, the greater the variability of losses around their expected value.

From a statistical point of view, the volatility of the expected loss depends only on the probability of the default occurring. Therefore, it is possible to refer to a binomial distribution and the formula will be described as follows:

$$\sigma = \sqrt{EL^2(1 - PD) + (EL - LGD * EAD)^2 PD}$$
(10)

From here, substituting EL = EAD * PD * LGD gives:

$$\sigma = LGD * EAD * \sqrt{PD(1 - PD)}$$
(11)

This formula assumes that the variables LGD and EAD are independent of each other, i.e., the calculation of one does not affect the calculation of the other. In the opposite case, it would be necessary to add the covariance of the variables. It should be noted that aggregating individual positions in a portfolio can result in significant diversification benefits. Indeed, the amount of capital required to cope with unexpected losses may be less than the sum of the capital to be held against unexpected losses for individual transactions.

Below is a graph showing the two types of losses in relation to their frequency (*Figure 3.4*). The value at risk will therefore be divided into expected loss, which will have a higher frequency and value, and will be covered by risk premiums, as well as unexpected loss, which will be covered by economic equity. The part of the graph to the right of the unexpected loss can be defined as an exceptional or potential loss, whose probability of occurrence is around 0.1%, i.e., only in extremely rare cases.



Figure 3.4 - Frequency of expected loss and unexpected loss (Source: BCBS, 2005)

Despite the possibility of combining more assets, the reduction in this variability can never fall below a certain threshold, as there are underlying risks present in the economy itself, referred to as systematic or unavoidable risks¹⁶. However, by studying the various models with 99% confidence intervals, it is possible to conservatively estimate a measure of loss that would allow a coverage of 99 out of 100.

¹⁶ Systematic risk is the risk component of an asset that cannot be eliminated also with diversification because it is linked to general market variations.

3.2) The importance of Risk Management

The term risk management refers to the set of processes through which a company identifies, analyses, monitors and quantifies the risks associated with a given production process. The main objective is to minimize losses while maximizing the effectiveness and efficiency of production processes.

In recent years, this function has made considerable progress and has become more than essential as the increasing evolution and dynamism of the market have placed large banks and companies in a position to face ever higher risks. The current context of global crisis contributes to emphasizing the importance of knowing the risks of one's own company in order to make the best possible use of them, both in prosperous market situations and especially in periods of recession.

In particular, CRM (Credit Risk Management) has been given increasing attention as credit institutions have felt the need to take on higher risks, which had to be offset by consistent mitigation techniques. Compared to other risk types, credit risk has been assigned a higher importance, mainly due to the weight of lending activities in total assets held in the portfolio and the significance of credit losses. As confirmation of this, it has been studied that proper risk management is closely correlated to economic performance, so much that there is a 34% increase in ROI¹⁷ and 39% increase in ROE¹⁸ for those who adopt proper risk management measures.

In this sense, a model to be followed with the aim of reducing and managing this type of risk in the best possible way is the so-called 5Cs rule, which includes:

- Cash flow: the counterparty's ability to meet its obligations based on expected liquidity.
- Capital: an accurate assessment of the counterparty's ability to meet its commitments through capital investments is essential.
- Conditions: the credit institution must consider the counterparty's contextual conditions.

¹⁷ The return on investment is an index that indicates the rate of return on a company's total investments.

¹⁸ Return on equity is an index that indicates the return on risk capital, i.e. the investment made by shareholders in the company.

- Character: a precise and careful study of the counterparty, its ability to repay its debts and its reputation is of foremost importance.
- Collateral: the value of the counterparty's assets, which could be used as collateral, must be considered.

Hence, it can be said that risk management is permeating, in all its facets, through daily life of any organization and must now, more than ever, be framed and included in strategic planning processes. Only in this way will the world economy be able to progress in the right direction, without falling back into global financial crisis which have caused colossal damage.

4) A practical case of Incorporation - The experience in Deloitte

The project analysed in the following paragraphs concerns the investigation carried out by Deloitte - and specifically the working group I was assigned to during the months of my internship - as a support to the merger by incorporation of two Italian Banks, with the aim of fostering the proper implementation of credit portfolio management systems, according to the European Regulation in force.

The internship took place at Deloitte Risk Advisory Srl, one of the world's leading consulting and services companies, between April and June 2021. The experience concerned the field of risk management, more specifically the areas related to credit risk and market risk. Through the involvement in the project, I had the opportunity to face important realities of the Italian banking sector, particularly the process of acquisition by incorporation. Owing to the presence of an inclusive team, which allowed me to actively collaborate in the main daily activities, I was able to integrate and to deeply understand the main business operations that characterize large companies like Deloitte.

Deloitte Risk Advisory Srl. is part of the Deloitte Touche Tohmatsu Group and is a consulting and auditing services company, known to be the first in the world in terms of revenues and number of professionals. It employs over 240,000 people worldwide and operates in sectors such as Audit & Assurance, Consulting, Tax, Financial Advisory and Risk Advisory. It is headquartered in London, but it operates in more than a hundred countries worldwide. For many years the organization and its network of member firms were legally organized as a Swiss Verein, that is the equivalent of an unincorporated association, but then the members of the Verein became part of Deloitte Touche Tohmatsu Limited (DTTL), in which the member firm of its global network remains an independent legal entity, subject to the laws of the country in which it operates. Being such a large firm, Deloitte bases its culture on inclusion and collaboration, offering great opportunities to young people who want to gain experience. In the area of Risk Advisory, the company offers a wide range of services with the main purpose of helping organizations to make strategic choices on business processes, still aware of the associated risks, in order to stimulate business and protect their reputation. In addition, it assists its clients to anticipate and address changes in the regulatory environment and to

implement more effective programs and controls to mitigate the huge variety of regulatory risks.

The main areas of application that I was engaged in during my internship included activities such as the study and development of internal risk models and impact simulations related to the banking sector, both from a quantitative and a qualitative point of view.

For the purpose of this paper, the two Italian banks under examination will not be referred to as with their real names due to privacy issues and will therefore be renamed "North Bank" and "South Bank". The merger will take place through the incorporation of South Bank, which has a significantly reduced market share compared to the other one, into North Bank, which will continue to exist under the same name and with a higher influence in the Italian banking scene. This process would generate relative benefits in terms of pooling resources, increasing the market share and decreasing the operating costs.

The objectives set by the project team were firstly to define the regulatory position of the two banking institutions, supported by an in-depth study of the individual portfolios, and a subsequent analysis of the impacts on the former following the merger. The confrontation with such a large bank merger made it necessary to interact with the ECB¹⁹ to define the standards and procedures to be followed during the examinations in order to comply with all the regulatory requirements. In this context, the task of the Group was to prepare a "regulatory self-assessment" defining the areas of non-compliance with the specific Regulation following the merger, as well as a "return to compliance plan" providing indications of the strategy that the Group would follow to restore such compliance and defining the correct actions with the relative timing that would lead to the extension of the internal credit risk models to the acquired portfolios of the other bank.

The work was structured in such a way that there was extensive collaboration between team members, including several weekly meetings that enabled the alignment of activities and in which consistency with set deadlines was assessed. Furthermore, monthly meetings were established during which a SOP (i.e., state of progress) document was

¹⁹ The European Central Bank (ECB) is the central bank responsible for implementing monetary policy for the 19 European Union countries that have joined the single currency, forming the so-called euro area, as well as for supervising credit institutions.

proposed to include the activities carried out by the team during the month and any critical issue, so that the client could be kept constantly updated on the progress of the activities.

4.1) Merger by acquisition - Overview

By definition, a corporate or banking merger is an operation whereby two or more companies or banks merge to become a collective entity. More specifically, a merger by acquisition is a merger whereby one company, known as the acquiring company, absorbs the other, known as the acquired company, thereby extinguishing it. In this sense, the shares or quotas of the company being acquired are cancelled and, instead, shares or quotas of the acquiring company are assigned to the shareholders, to the extent determined by the exchange ratio. From a financial point of view, the balance sheet of the new banking Group contains the assets and liabilities of the merged banks.

The following figure shows an outline of how a merger by acquisition of two companies evolves (*Figure 4.1*).





Figure 4.1 - General scheme of a merger by acquisition

However, it is not possible to speak of a real extinction of the merged entity since, pursuant to the new Article 2050-bis of the Italian Civil Code, "the merger by

incorporation between companies does not determine the extinction of the incorporated company, nor does it create a new legal entity in the case of an equal merger, but implements the unification through the mutual integration of the companies participating in the merger, resulting in a merely evolutionary-modifying event of the same legal entity, which retains its identity even in a new organizational structure. "

In the context, with regard to a bank merger, a fundamental role is played by the ECB, which is the main body giving its consent and determining its final approval. Nevertheless, it should be noted that in addition to the ECB, mergers by incorporation are also directly regulated by national law, so if the law of the country at stake gives merger powers to the national supervisory authority, the ECB only exercises them in the event banks it directly supervises are involved. In the case of Italy, the competent national authority has the power to approve mergers and for this, if two banks decide to merge, the ECB's Supervisory Board only assesses the impact of the operation on the new bank in terms of profitability, solvency and liquidity, organizational set-up and technical ability to meet governance requirements.

With regards to the actual merger process from a general point of view, the ECB has the task of assessing the proposed acquisition and therefore the acquiring bank will have to meet several requirements, including:

- Financial soundness of the acquirer, through which it is assessed whether the acquiring company has the ability to financially support the acquisition and to maintain a sound financial structure in the future.
- Honourability of the proposed acquirer: an assessment of whether the acquiring entity has the integrity and reliability necessary for an acquisition and has prior experience in the sector.
- Impact on the bank, i.e., the financial and economic consequences of the acquisition on the bank.
- Reputation and experience of proposed new directors, namely an assessment of the professionalism and integrity of the new officers.

Among this long list of requirements, our analysis concerns the applicability of the risk assessment models used by the acquiring bank based on the acquiring bank's models. In other terms, our task consists in examining the parameters through which the banks

assess the risk of their debtors, evaluating whether they comply with the ECB Regulation and possibly transposing them in the IT systems while carrying out impact simulations showing the post-acquisition scenario.

4.2) Project goals

The present work aims at illustrating the support provided for the merger of North Bank and South Bank, who have agreed to merge and therefore requested service from Deloitte for what concerns risk management and internal credit risk models. In order for such a merger to take place within the timeframe and limits provided for by the Regulation, it is necessary to undertake analyses of the credit portfolios of the two banks and to assess their comparability in terms of customer risk assessment. Our work will indeed focus on the study of the risk models used by the two banks with the aim of extending the credit risk models of North Bank to the acquired portfolios during the merger. To this aim, it is necessary to conduct investigations that lead to results that comply with the imposed Regulation. Such results include that the change in RWA defined as the summary of the main risk factors attributable to a given financial asset which are considered to adjust the nominal value of the asset, i.e., the risk weight multiplied by the value of the exposure - is below a certain threshold while still allowing for variations due to the nature of the merger.

Therefore, the final objective of the work will be to illustrate the investigations on the loan portfolios of both banks in order to classify the changes resulting from the acquisition as non-substantial, thus avoiding the notification to the ECB prior to implementation which would require longer timeframes and much higher costs. According to EU Regulation no. 529/2014, a substantial change "(...) results in a change of 15 % or more in the credit risk-weighted and dilution risk-weighted exposure amounts associated with the scope of application of the internal rating system or the internal models-based approach to calculating equity exposures (...)". This means that it will be necessary to calculate and assess variations in RWAs for each individual portfolio both before and after the merger in order to verify that this percentage change is below the 15% threshold and allow for the proper implementation of the systems.

Substantiality of changes refers to the impact that the merger will have, in the context of credit risk, in terms of exposure and capital buffers to be set aside on the acquiring bank. In particular, the larger the changes to the loan portfolios and the greater the change in risk parameters, the more substantial and severe the changes will be, requiring a notification to be sent to the ECB. Therefore, achieving the goal of defining changes to loan portfolios as non-substantial is of paramount importance and will be the key focus of our analysis.

The study of the portfolios will focus on the risk models that the banks use for their customers, i.e., how different customers who have applied for a loan from the bank are classified according to their risk profile (more or less risky). As explained in the previous chapters, a bank, to lend money, needs to know what type of customer it is dealing with so that it can set aside sufficient money to cover any losses or deferred payments. Therefore, it needs to develop models and verify their authenticity. In the case of bank mergers, it is necessary to level out the credit risk measures of the two banks, so that the estimates made by the merged company can actually match those of the acquiring company, since the two portfolios will be combined. More in detail, in our case the two banks adopt two different approaches to measuring credit risk, which is precisely why the analyses to be performed turned out to be so complex. The purpose of our work will therefore be to assess whether the parameters used in the standard approach by South Bank can be transposed and converted into the internal models used by North Bank, i.e., whether the extension of North Bank's internal models to the portfolios acquired from South Bank can be granted.

Analyses will firstly focus on the study of the individual banks' portfolios, examining common and exclusive clients, and then on post-acquisition impact simulations, in order to assess whether it is actually possible to consider such changes as non-substantial. In addition, evaluation will be carried out on the various parameters used for the internal risk models, including PD, LGD and EAD with the consequent IT implementation. The final result will be a synthesis of all the data and will be represented by the RWA value, which will give a complete view of the risk profile of the portfolios following the merger.

4.3) Background

In 2020 North Bank and South Bank signed a framework agreement aimed at merging South Bank into North Bank with the relative authorization request to the ECB. The merger was approved by the National and European authorities and was allowed by the Board of Directors and the shareholders' meetings of both companies, which formalized the date of the merger, namely summer 2021. In this context, numerous investigations were carried out regarding the acquisition and the related impacts in the area of risk management, including an assessment of the internal credit risk models with the aim of:

- Defining the regulatory position of the two Banks following the acquisition, i.e., determining whether the processes and models related to the acquisition are compliant with the Regulations.
- Formalising a strategic plan to return to compliance that provides a defined strategy for extending internal credit risk models to South Bank.

In particular, the documentation that has been drafted by the project team consists of two official documents whose main purpose is to explore in detail all the regulatory aspects aiming at the acquisition, which are:

- A regulatory self-assessment, i.e., a self-assessment that the Bank must subsequently send to the ECB, defining in detail the areas of non-compliance of the internal risk model framework following the merger.
- A return to compliance plan, which clarifies the strategy that the Group will adopt to restore compliance with the Regulation, the concrete actions to implement the strategy and the respective timelines.

Below is a summary of the composition of the two documents with the relative steps to follow. (*Figure 4.2*).



Figure 4.2 - Main steps and composition of the documents to be drawn up

The main points to be included in the return to compliance plan document are summarized as follows:

- 1. Overview of portfolios, testing and impact analysis:
 - Overview of portfolios and related regulatory treatment of both Banks with analysis of common and exclusive customers.
 - Results of materiality²⁰, comparability²¹ and representativeness²² tests carried out for the purpose of extending North Bank's internal models to the acquired portfolios.
- 2. Opinion of the Control Functions:
 - Assessment by Internal Validation and Internal Audit of the quantitative and qualitative analyses performed.

²⁰ Materiality analyses are analyses carried out on the portfolios of the two banks aimed at verifying an increase or decrease in RWA, so as to be able to classify the changes implemented at the time of the acquisition as non-substantial.

²¹ EU Regulation 529/2014 requires that, at the time of a merger by acquisition, "the comparability of the population of exposures represented in the data used for estimation, the criteria followed for lending at the time the data were produced, and other relevant characteristics, with the data on additional exposures in the case of lending decided by a third party".

²² From a statistical point of view, the representativeness of a sample is its ability to reproduce, as closely as possible, the characteristics of the statistical universe from which it is drawn.

From a practical point of view, in accordance with the provisions of the reference regulatory framework, the main quantitative and qualitative analyses and tests that will be perform are as follows (*Table 4.1*):

Materiality Test	 Verify a maximum 15% reduction/increase in RWA amounts calculated at the level of each regulatory asset class.
Exposure	 Evidence on shared customers and subsequent assessment of the materiality of the increase in exposure and number of counterparties observed post-acquisition compared to the pre-acquisition portfolio.
Representativeness Test	 Evaluation of the representativeness of the pre- and post-acquisition classes of the respective portfolios with the support of some indices. Evaluation of class representativeness between the development samples of the various models (recalibration samples) and their post- acquisition portfolios.
Comparability Test	 Qualitative assessment of the characteristics of South Bank's acquired products, counterparties and types of collateral supporting the loan. Comparison of average values of risk parameters of pre- and post-acquisition portfolios. PD and LGD calibration.

 Table 4.1 - Main analyses performed for the project

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 Backtesting of models on post-acquisition portfolios to also assess the resilience of their discriminating power.

4.4) Analysis of risk models on portfolios

The first evaluations focused on the individual portfolios of the single banks and illustrate the materiality and regulatory treatment to which they are subjected, providing indications of the impact on RWA resulting from the plan to return to compliance. In the following paragraphs, the different types of customers of the two banks will be indicated with the relative risk parameters, with regards to both performing and non-performing²³ portfolios. Another distinction that will be made concerns two types of models which are:

- 1) Models in production, i.e., the internal models currently in use.
- 2) Models in validation, i.e., models that have been requested for implementation by the bank at the ECB and are not yet in production, including a new PD measure.

4.4.1) Description of North Bank portfolios

North Bank adopts an advanced AIRB approach *(see Chapter 2.4.2)* to credit risk measurement for Corporate and Retail portfolios, which has allowed it to better understand, quantify and control risk, also increasing transparency, both internally and from a regulatory perspective. In addition, the use of internal models has supported the business areas through more informed decision-making in their business processes and activities. Indeed, as mentioned before, the decision to adopt internal models to assess credit risk, despite their complexity, brings with it numerous benefits, including a more concrete and realistic view of customers. This is because it is no longer external rating agencies that give a subjective assessment of clients, but the bank itself that determines the rating.

²³ Non performing portfolio indicates bank loans that borrowers are no longer able to repay regularly or in full. In practice, these are bank loans for which collection is uncertain both in terms of compliance with the deadline and the amount of capital exposure.

The segmentation of performing portfolios consists of:

- "Corporate", which defines a customer segment corresponding to medium and large-sized companies.
- "Enterprise Retail", which marks a customer segment comprising small enterprises.
- "Retail", which refers to a customer segment that mainly includes private individuals, professionals, shopkeepers and artisans and can be further divided into:
 - "Private Retail", which identifies private individuals both with concessions and upward variations of medium-term loans (excluding personal loans and salary-backed loans) and with concessions of credit facilities other than medium-term loans (excluding account credit facilities up to €10,000 and credit cards).
 - "Instalment Pool", defining customers who have stipulated an instalment loan with the bank and who undertake to repay it in instalments at set intervals and amounts.
 - "Pool revolving", referring to private customers who have requested a loan with a predefined medium/long-term duration intended to support any transitory cash requirements or for purposes connected with the realisation of investments not yet amortised in the sector of research and development.
 - "Pool cessione del quinto", defined as a loan from a pay slip or pension with repayment in instalments at a constant rate.
 - Pool overdraft.

With regards to the segmentation of non-performing portfolios, they are divided as follows:

• "Past Due", which identifies the category of loans that are past due and/or in arrears for more than 90 days and included in the category of defaulted positions.

- "Unlikely to Pay", which is defined as exposures for which the bank determines that the borrower is unlikely to meet its contractual obligations in full without recourse to actions such as the enforcement of collateral.
- "Sofferenza", identified as exposures to borrowers who are insolvent or in substantially similar situations.

Table 4.2 below provides an overview of North Bank's AIRB performing loan portfolios for both models in production and models under validation. Specifically, the table shows the nominal value of the different portfolios (expressed in \in M) along with the different parameters of the integer risk models such as:

- PD (or ELBE) or Probability of Default;
- LGD or Loss Given Default;
- EAD or Exposure at Default;
- RWA or Risk Weight Assets;
- RWA density, defined as the ratio of RWA to total asset exposure (EAD). An increase in RWA density over a period shows that overall risk profile of bank assets has deteriorated.
- EL or Expected Loss, defined as the product of PD, LGD and EAD.

		Mo	Models in production				Models in validation				
PORTFOLIO	NOMINAL (€/M)	PD	LGD	EAD	RWA	EL	PD	LGD	EAD	RWA	EL
Corporate	15.342	0,80%	41,5%	9.117	3.881	30,3	1,04%	32,27%	9.467	3.630	31,9
Enterprise Retail	1.664	4,01%	29,7%	1.332	533	15,9	5,31%	18,17%	1.354	361	13
Private Retail	8.976	1,16%	22,4%	8.794	2.598	22,9	1,62%	13,77%	8.704	1.913	19,4
Instalment Pool	499	2,21%	44,6%	520	310	5,1	2,54%	30%	455	194	3,5
Pool Revolving	930	1,24%	28,7%	1.150	208	4,1	1,69%	22,15%	412	77	1,5
Pool Cessione del Quinto	456	1,24%	3,03%	455	17	0,17	4,09%	4,71%	455	37	0,87
Pool Overdraft	18	14,85%	23,1%	18	11	0,62	21,37%	13,75%	39	16	1,14
PERFORMING TOTAL	27.885	1,22%	31,5%	21.386	7558	82	1,71%	22,76%	20.886	6.228	81

 Table 4.2 - Overview of North Bank's performing portfolios

As the table shows, North Bank's total performing loan portfolios have a nominal value of $\notin 27.885M$, with the main component being the Corporate portfolio with a nominal value of $\notin 15.342M$. For each of the portfolios, the values of the risk models calculated by the bank itself using the AIRB approach are also shown, both for models in production and for models under validation. The highest expected loss value understandably, which is the product of PD, LGD and EAD corresponds to the Corporate portfolio ($\notin 30M$), although the probability of default is lower than in the other segments. This can be explained by the fact that the bank assesses as riskier a private client applying for a loan than a large company, which has all the requirements to repay the debt. Finally, the last row of the table shows the total performing, defined as a weighted average of the different nominal values and individual parameters.

Table 4.3 below provides a general overview of the non-performing portfolios. Unlike the PD parameter, in this case the ELBE parameter is developed, which represents a better estimate of the expected loss for defaulted exposures.

		Μ	Models in production				Models in validation				
RISK STATUS	NOMINAL (€/M)	LGD	ELBE	EAD	RWA	EL	LGD	ELBE	EAD	RWA	EL
Past Due	53	17,98%	17,41%	43,2	3,6	1,35	12,54%	10,33%	50,4	16,2	0,65
Unlikely to Pay	315	36,61%	34,26%	298,8	97,2	37,48	33,37%	30,56%	328,5	127,8	33,51
Sofferenza	349	83,27%	81,05%	349,2	108	235,66	66,17%	63,73%	349,2	118,8	147,25
NON PERFORMING TOTAL	717	59%	56,8%	691,2	208,8	231,72	47,64%	45,05%	728,1	261,9	156,24

Table 4.3 - Overview of North Bank's non-performing portfolios

The total nominal value of the non-performing portfolios is around €717M, with very high LGD and ELBE values, about 60% in model in production and 50% in models in validation since they are part of the riskiest component for the bank. What is most apparent from an initial analysis of North Bank's portfolios is the variety of their composition. They comprise several different types of exposures, ranging from a home loan to a private individual to a machinery investment for a large corporate segment. The combination of such a large number of portfolios has the immediate consequence of

reducing the overall risk, since a riskier, higher-yielding exposure will be balanced by a less profitable but equally much safer one. Of all the parameters, the RWA is the most important value to take consider since it is a linear combination of all the others, related to the value of the exposure and corresponds to the value that the ECB considers when evaluating the acquisition of portfolios during a merger. In this case, the RWA values that North Bank has estimated through its internal models are \in 8,000M for the performing portfolios and \notin 230M for the non-performing portfolios. Considering that North Bank's total assets amount to \notin 28,000M, it is possible to observe an RWA to Assets ratio of 29%, which is higher than the national average, certifying the proper functioning of internal models and a careful risk assessment from all points of view. The solidity of a bank can be seen from these details: keeping RWA values below a certain threshold would entail lower capital reserves, but at the same time it would put the entire banking system at risk. It is from this process that the need for a level playing field has arisen, setting the guidelines for a more solid and stable future.

4.4.2) Description of South Bank portfolios

South Bank, being a small company compared to North Bank, does not adopt internal models to assess the credit risk of its customers, but uses a standard approach, which consists of assigning a rating by specialised agencies. Therefore, in the description of the different portfolios, the PD and LGD parameters will not be taken into consideration as they are typical of the IRB methods, while we will find the EAD and RWA values typical of the standard method. Similarly to North Bank, the subdivision of portfolios remains unchanged.

The following is an overview of South Bank's performing perimeter (Table 4.4).

PORTFOLIO (€/M)	NOMINAL	EAD	RWA
Corporate	952	550	400
Enterprise Retail	194	149	93
Private Retail	507	490	202
Instalment Pool	23	22	17
Pool Revolving	8	3	2
Pool Cessione del Quinto	0	0	0
Pool Overdraft	4	1	1
PERFORMING TOTAL	1.688	1.215	715

Table 4.4 - Overview of the performing perimeter of South Bank

The nominal value of performing exposures, as shown in the table, is €1.688M, which is significantly lower than that of North Bank. Again, the largest segment is the Corporate with a nominal value of exposures of €952M and a relative RWA of €400M.

With regard to the non-performing perimeter, details by risk status are provided below (*Table 4.5*).

	1 5	81 5	
RISK STATUS (€/M)	NOMINAL	EAD	RWA
Past Due	5	4	6
Unlikely to Pay	45	28	34
Sofferenza	76	27	34
NON PERFORMING	126	59	74

Table 4.5 - Overview of South Bank's non performing portfolios

TOTAL

In this case, the total nominal value of non-performing exposures is $\in 126M$, of which the vast majority belongs to the "Sofferenza" segment with a nominal value of $\in 76M$ and RWA of $\in 34M$. This first general analysis of the two bank shows the great disparity, in terms of exposures, among them in the nominal values of the different portfolios and consequently of the values at risk. In fact, considering the performing portfolio, if on one hand North Bank has about $\in 28.000M$ of exposure with a total RWA value of about $\in 8.000M$, on the other hand South Bank has a total of about $\in 1.700M$ of exposure and about €800M in terms of RWA. At first glance, it emerges how different the two banks are in terms of size, which is why the risk assessment approaches adopted are different. In addition, having a smaller credit size cannot always be considered an advantage, since a factor affecting risk is precisely portfolio diversification, which will be greater if the portfolio size is larger. In fact, the above data show that, although South Bank has exposures that are about 15 times smaller than North Bank's, the RWA values do not correspond proportionally to North Bank's but are much higher, which means that the bank is assessing its customers as very risky.

As discussed in previous chapters, the reasons for using the standard approach for South Bank are the small size of the institution and the relatively few exposures it faces. In the context of a small banking reality such that of South bank, the role of specialised rating agencies is indeed to avoid wasting time and resources to build models internally that would ultimately lead to the same result. In this case, the two parameters that are calculated by these rating agencies are, in addition to the nominal value, the EAD and the RWA since the former identifies an estimate of the actual value of the loan in the event of default and the latter a summary of the main risk factors related to the asset's value. Such parameters have been calculated using a rating table that assigns a coefficient to each exposure based on the type of risk, which will be then multiplied by the nominal value of the assets. A brief synopsis of the RWA ratios for each portfolio over the nominal value of the assets shows that the Private Retail portfolio is the riskiest, with a ratio of 41%, which is explained by the riskiness that must be assigned to an individual private individual due to its internal variability.

4.4.3) Assessment of acquired exposures and clients

As is the case with most mergers by incorporation, it is possible for two banks to have the same client (common clientele) or to have clients exclusive to the individual bank. The advantages of having the same client, in the case of a merger, are manifold: first, knowing the risk status of the customer without having to undertake further analyses that are not only time-consuming but also costly is a main convenience. Therefore, a key assessment consisted of a comparison of the common and exclusive clients of the two banks and their relative exposures, shown in *Table 4.6*. A summary - at exposure level - of the performing portfolio of the two banks is presented, highlighting the share of common counterparties and the increase generated by the South Bank perimeter. The last two columns identify the percentage of common counterparties of both the individual segments and the total and the increase generated by the acquisition on North Bank portfolio.

	South Bar	ık (€/M)	North Bank (€/M)	% in	% increase (a/(a+c))	
PORTFOLIO	NOMINAL (a)	of which in Common (b)	NOMINAL (c)	Common (b/a)		
Corporate	952	340	15.342	35,71%	5,84%	
Enterprise Retail	194	5	1.664	2,75%	10,45%	
Private Retail	507	1	8.976	0,26%	5,35%	
Instalment Pool	23	0	499	0,94%	4,48%	
Pool Revolving	8	2	930	24,33%	0,88%	
Pool Cessione del Quinto	0	0	456	100%	0%	
Pool Overdraft	4	3	18	88%	15,53%	
TOTAL	1.688	351	27.885	20,8%	5,7%	

Table 4.6 - Increase generated by the acquisition and common counterparts acquired

The portion of acquired portfolios consisting of common counterparties with North Bank, with consequent benefits in terms of knowledge of the riskiness of exposures, is approximately equal to 21% in terms of exposure. On the other hand, with regards to the relative weight of acquired portfolios compared to North Bank's, the increase in validated portfolios would be approximately 5.7%. An even more detailed analysis is presented in *Table 4.7*, which denotes the total post-acquisition portfolio, again in \in M with the relative increase for each segment. Qualitative analyses on the acquired performing portfolio were performed in order to verify the significance of the increase in overall exposure compared to the initial portfolio.

	Exposure (€/M)							
	Corporate	Enterprise Retail	Retail	TOTAL				
Initial portfolio - North Bank	15.342	1.664	10.878	27.885				
Acquired portfolio - South Bank	952	194	542	1.688				
Total post-acquisition portfolio (North Bank + South Bank)	16.294	1.858	11.420	29.573				
% Increase	5,84%	10,45%	4,74%	5,7%				

Table 4.7 - Total South Bank + North Bank portfolio post-acquisition

In addition to the assessment of acquired exposures, an evaluation of the share of common and exclusive clients was also performed (*Table 4.8*).

Table 4.8 - Common and acquired clients

		Exposu	re (€/M)	
Client Type	Corporate	Enterprise Retail	Retail	TOTAL
Exclusive (a)	612	189	536	1.337
Common (b)	340	5	6	351
Total (a+b)	952	194	542	1.688
% Common Clientele	35,7%	2,6%	1,1%	20,8%

It should be noted that the share of common clients in the performing portfolio is about 21% in terms of exposure, with the highest incidence in the Corporate segment (about 36%) and the lowest in the Retail segment (about 1.1%). The fact of having a good percentage of common counterparties can certainly be seen as an advantage, since one is better informed about the riskiness of customers, but on the other hand it can also have a negative side. Knowledge does not necessarily imply a decrease in risk, but it simply helps in the process of assessing risk and therefore setting aside money. In fact, it is possible that part of the common clientele is the riskiest and for this reason it would still be necessary to be prepared with sufficient money in case insolvency occurs.

4.4.4) Corporate Portfolio

The examination in the previous paragraphs focused on the portfolios of the two banks from a general point of view, without going into the specifics of the individual portfolios and the individual risk parameters that characterise them. From here on, the evaluation will concern the specific portfolio with indication of North Bank's internal models to be extended to the acquired one. Starting from the analysis of the merged bank's portfolio, impact assessments will be carried out on the risk parameters in order to adapt them to the new models implemented by the merging company. For each portfolio, the steps that will be followed are:

- Overview of the exposures of the analysed segment of South Bank, with the respective EAD and RWA parameters, defined by the rating agencies;
- Addition of the average risk parameters (PD and LGD) applied to the portfolio under consideration;
- Simulation of the impact and change in the RWA parameter following the merger.

Corporate segmented clients include companies with individual or group turnover in excess of $\in 1M$ or with an exposure more than $\in 1M$.

The table below shows the type of client (exclusive or common) with the relative nominal value and the individual risk parameters of South Bank's pre-acquisition Corporate portfolio (*Table 4.9*).

			South Bank (€/M)					
PORTFOLIO	CLIENT TYPE	# CLIENTS	NOMINAL	EAD	RWA			
	Exclusive	815	612	367	265			
Corporate	Common	237	340	183	135			
	TOTAL	1.052	952	550	400			

Table 4.9 - Risk parameters of the Corporate segment pre-acquisition

The total number of South Bank's customers falling within the Corporate segment is 1.052, with a nominal value of around \notin 952M, which means that on average a client has a loan with the bank of about \notin 1M. RWA values, which were calculated directly by South Bank using specialist rating agencies, correspond to \notin 400M including exclusive and

common clients, but, through simulation in North Bank's models, it is expected that they may decrease since, having a fairly high percentage of common customers, a part of the customers is already within the models and has already been carefully studied.

With reference to the impacts deriving from the extension of North Bank's internal models to South Bank's acquired portfolio, the average risk parameters (PD and LGD) applied for the RWA simulation are shown below (*Table 4.10*).

		Mode	els in pro	oduction	Mod	els in val	lidation
PORTFOLIO	CLIENT TYPE	PD	LGD	% EL (PD*LGD)	PD	LGD	% EL (PD*LGD)
	Exclusive	1,1%	39,5%	0,4%	1,48%	30%	0,44%
Cornorato	Common	1%	41%	0,41%	1,3%	32%	0,41%
Corporate	TOTAL	1,05%	40%	0,4%	1,39%	31%	0,43%

Table 4.10 - Risk parameters of the Corporate segment post-acquisition

The total value of the parameters, in terms of percentage, is calculated as a weighted average of the latter and the respective share of customers. The total expected loss following the incorporation of South Bank, as far as the Corporate segment is concerned, is 0.4% higher, a value that was obtained through the product of the PD and LGD parameters, which in turn were obtained by entering the values of South Bank's exposures into North Bank's internal statistical models. The PD values that emerged from this simulation perfectly reflect the nature of the portfolio, which is subject to low risk and low probability of default and are in line with the North Bank values.

On the other hand, the calculated LGD values are around 40% for the production models and 31% for the validation models and are considered to be quite high. An explanation for this result lies in the definition of Loss Given Default, i.e. the loss of credit that cannot be recovered through legal action. When dealing with segmented corporate clients, i.e. large companies, whose probability of bankruptcy is expected to be very low, it is also expected that in the few cases where such an event occurs, only a small part of the debt will be recovered, due to court costs and the time required for the recovery attempt. Conversely, with Retail portfolios the situation is the opposite: PD values are higher while LGD are lower as they would be less costly from a legal point of view. To

conclude, *Tables 4.11 and 4.12* below show the preliminary results of the assessment performed on the RWA impacts deriving from this extension, both for the models currently in use and for the models under validation. They represent a real simulation of how the values of the parameters of South Bank will change with the advent of the merger.

	South B acquisi	Bank (bei ition) (€/	fore M)	S a	outh Ban cquisitio	ık (after n) (€/M)	DELTA
PORTFOLIO	NOMINAL	NAL EAD RWA			EAD RWA DENSITY (RWA/EAD)		
Corporate	952	550	400	581	289	49,7%	-111

 Table 4.11 - RWA simulation for production models

Table 4.12 - RWA simulation for models under validation

	South Bank (before acquisition) (€/M)			â	DELTA		
PORTFOLIO	NOMINAL	EAD	RWA	EAD	RWA	RWA DENSITY (RWA/EAD)	RWA
Corporate	952	550	400	575	262	45,5%	-138

As it can be inferred from the tables above, the value of EAD increased as exposure increased significantly with the purchase of portfolios, while there was a good decrease in RWA, mainly due to the new diversification of the portfolios and the participation of common customers. The results achieved through this first simulation led to a total RWA value on the Corporate portfolio with the models in production of around €289M and the RWA density value calculated is around 50%: thus the projection generated a decrease in RWA of around €111M. With reference to the simulation on the Corporate portfolio with the validating models, the total RWA value is equal to €262M and the calculated RWA density is about 46%: as a consequence, the model generated a decrease in RWA of about €138M.

A first explanation of these results can be given by the lower exposure of South Bank compared to North Bank. In both cases the segment with the highest exposure corresponds to the Corporate segment, which in turn is matched by a higher provision of capital reserves as it is the one with the highest RWA. Now, considering the difference in exposure between the two banks, it is easy to understand why by including South Bank's risk data in North Bank's models, the former's RWA decreases. What was initially considered riskier for South Bank it is no longer such following the merger process, as it becomes part of a larger segment that assesses its customers with different risk parameters and therefore has a much less pronounced influence. Whereas previously the corporate exposures of South Bank had an influence of about 70% on all portfolios, with the merger the influence on the overall portfolio of North Bank and South Bank decreases to 10% and the RWA value decreases.

Furthermore, from a technical point of view, as regards the values of the risk parameters, two simulations were carried out applying North Bank parameters (PD, LGD, EAD) based on the internal Corporate models in use and under validation. Regarding the LGD and EAD parameters, the drivers on South Bank's portfolio were reconstructed by applying some proxies in order to access the appropriate grids. The PD parameter, on the other hand, was assigned to common counterparties based on North Bank's ratings, while exclusive customers were assigned PDs per portfolio by applying a correction factor to South Bank's default rates in the presence of greater riskiness on the average PD of North Bank's portfolio. A more in-depth analysis on the calculation of parameter values will be further studied in the next paragraphs.

4.4.5) Enterprise Retail Portfolio

For the "Enterprise Retail" portfolio, both micro-enterprises (corporations and other companies in ordinary accounting, with turnover and exposure of less than $\in 1M$) and micro-businesses (partnerships, sole proprietorships, self-employed professionals in simplified accounting, with turnover and exposure of less than $\in 1M$) have been included.

The procedure followed in this case is the same as for the simulations for the Corporate portfolio. Therefore, in the tables below we report the materiality of South Bank's Enterprise Retail portfolio, based on North Bank segmentation (*Table 4.13*).

			South Bank(€/M)				
PORTFOLIO	CLIENT TYPE	# CLIENTS	NOMINAL	EAD	RWA		
	Exclusive	2.105	189	147	91		
Enterprise Retail	Common	51	5	3	1		
	TOTAL	2.156	194	150	92		

Table 4.13 - Risk parameters of the Enterprise Retail segment Pre-acquisition

In this case, the number of clients compared to the Corporate segment is higher, however this corresponds to approximately 2,156 institutions with a significantly lower nominal value of \in 194M given that the clients taken into consideration refer to small and medium-sized enterprises, whose exposures are smaller. As a result, the EAD and RWA values are also less influential, at around \in 150M and \in 92M, respectively.

With regard to the impact of the extension of the internal models to the acquired South Bank portfolio, *Table 4.14* below represents the average risk parameters (PD and LGD) applied for the simulation of RWA.

		Mo	dels in pro	oduction	Models in validation		
PORTFOLIO	CLIENT TYPE	PD	LGD	% EL (PD*LGD)	PD	LGD	% EL (PD*LGD)
Enternrise	Exclusive	4%	30%	1,2%	5,3%	18,5%	0,98%
Retail	Common	4%	29%	1,16%	5,9%	18%	1,05%
	TOTAL	4%	29,5%	1,18%	5,6%	18,3%	1,02%

Table 4.14 - Risk parameters of the Enterprise Retail segment post-acquisition

The expected loss here is slightly higher than in the Corporate segment and is around 1,2%. However, this is not a critical value since the exposures are very low and do not lead to severe losses. The main cause for the increase in the expected loss lies in the intensification of the probability of default with respect to LGD. While in the Corporate portfolio the factor that most influenced the expected loss was LGD, in this case for the Enterprise Retail portfolio it is PD. An interpretation of this phenomenon is given by the higher internal variability of the clients analysed in this segment, with a consequent higher probability of being insolvent due to their lower solidity compared to companies and institutions pertaining to the Corporate segment. In addition, LGD values are lower

compared to the Corporate segment - 30% and 18% respectively for the two models analysed - since the hypothetical judicial process expenses and the time taken would be much lower.

Finally, below are the results of the preliminary analyses performed on the impacts of the RWA resulting from the extension for both models currently in use and for models being validated, in which the RWA situation before and after the acquisition is compared (*Table 4.15-4.16*).

South Bank (before South Bank (after acquisition) (€/M) acquisition) (€/M) DELTA RWA RWA PORTFOLIO NOMINAL EAD RWA EAD RWA DENSITY **Enterprise Retail** 194 149 93 164 74 45,1% -19

Table 4.15 - RWA simulation for production models

Table 4.16 - RWA simulation for models under validation

	South I	fore	So				
	acquisition) (€/M)			aco	(€/M)	DELTA	
PORTFOLIO	NOMINAL	EAD	RWA	EAD	RWA	RWA DENSITY	RWA
Enterprise Retail	194	149	93	166	49	28,9%	-44

Regarding the simulation on the Retail Enterprise portfolio with the models in production, the total recalculated RWA value is approximately \notin 74M and the calculated RWA density is approximately 45%: the simulation therefore generated a decrease in RWA of approximately \notin 19M. As regards the simulation of the Retail Enterprise portfolio with the validating models, the total recalculated RWA was approximately \notin 49M and the calculated RWA density was approximately 29%: the simulation generated a decrease in RWA of approximately \notin 44M.

The simulation outputs in this case also led to a decrease in RWA, mainly due to the low influence of this segment on North Bank's overall performing portfolio. However, despite covering only a small portion of the bank's entire portfolio, this segment is considered extremely important from both a bank and client perspective, as it allows some companies with turnover below a certain threshold to be classified as "Retail". Not only does this mean a lower cost for the company itself, which sees its lending rates fall considerably, but it has also led over the years to an ever-greater reduction in the costs incurred by the bank itself, implemented through a reduction in its regulatory capital reserves. Therefore, it is no coincidence that RWAs in this segment are lower than in others, resulting in lower risk exposure.

Another factor that stands out in the tables above is the RWA density of the models being validated, which is around 29%. It represents the ratio between the new values of RWA and EAD and has a much lower value compared to the other RWA densities, which means that a significant increase in exposure at default is matched by a significant decrease in RWA. Although it may seem ambiguous that an increase in exposure at default is correlated with a decrease in risk, it is indeed the scenario that occurs with the use of internal models compared to the use of a standard approach. One possible explanation is that the use of internal models modifies the method of assessing a client, evaluating it as less risky than using the other approach. This is certainly true, but the real question is whether such a decrease in risk assessment is actually realistic or only apparent, which is why it must come under ECB scrutiny.

4.4.6) Retail Portfolio

The Retail portfolio includes:

- "Private Retail", in which private individuals were included both with concessions and upward variations of medium-term loans (excluding personal loans and salary-backed loans) and with concessions of credit facilities other than mediumterm loans (excluding account credit facilities up to €10,000 and credit cards);
- "Product pool", which includes customers entrusted only with personal loans, overdraft facilities of up to €10,000, credit cards and salary-backed loans. In the presence of several products for the same customer, a criterion of univocality and prevalence was applied for the attribution of the rating according to the order indicated below:

- 1. Personal loans "Instalment pool";
- 2. Account overdrafts up to 10,000 or credit cards "Revolving pool";
- 3. "Cessione del quinto" "Pool cessione del quinto";
- 4. Overdrafts of uncredited accounts "Overdraft pool".

Again, we will assess the various risk parameters both before and after acquisition for each category of customer, as illustrated in the *Tables 4.17* and *4.18* below.

			South Bank (€/M)					
PORTFOLIO	CLIENT TYPE	# CLIENTS	NOMINAL	EAD	RWA			
	Exclusive	6.563	506	490	201			
Private Retail	Common	25	1	1	1			
	TOTAL	6.588	507	491	202			
Instalment Pool	Exclusive	1.834	23	22	17			
	Common	2	0	0	0			
	TOTAL	1.836	23	22	17			
	Exclusive	1.707	6	1	1			
Pool Revolving	Common	46	2	1	1			
	TOTAL	1.753	8	2	2			
Pool Cossiono dol	Exclusive	0	0	0	0			
Ouinto	Common	5	0	0	0			
Quinto	TOTAL	5	0	0	0			
	Exclusive	864	1	0	0			
Pool Overdraft	Common	10	3	1	1			
	TOTAL	874	4	1	1			
TOTAL RETAIL		11.056	542	496	222			

Table 4.17 - Risk parameters of the Retail segment pre-acquisition

		Mod	els in prod	luction	Models in validation		
PORTFOLIO	CLIENT TYPE	PD	LGD	% EL (PD*LGD)	PD	LGD	% EL (PD*LGD)
	Exclusive	1,50%	21,35%	0,32%	1,98%	15,48%	0,31%
Private Retail	Common	3,72%	23,12%	0,86%	3,88%	15,56%	0,60%
	TOTAL	1,51%	21,36%	0,32%	1,99%	15,48%	0,31%
Instalment	Exclusive	2,21%	44,28%	0,98%	2,54%	30,08%	0,76%
Pool	Common	1,78%	32,00%	0,57%	2,09%	23,68%	0,49%
	TOTAL	2,21%	44,17%	0,97%	2,54%	30,02%	0,76%
Pool	Exclusive	1,24%	28,61%	0,36%	1,69%	21,57%	0,37%
Revolving	Common	0,73%	20,18%	0,15%	0,99%	17,75%	0,18%
iteroring	TOTAL	1,12%	26,56%	0,30%	1,52%	20,64%	0,31%
Pool Cessione	Exclusive	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
del Quinto	Common	0,76%	2,31%	0,02%	2,42%	4,57%	0,11%
uei Quinto	TOTAL	0,76%	2,31%	0,02%	2,42%	4,57%	0,11%
Pool	Exclusive	18,34%	23,23%	4,26%	24,34%	13,63%	3,32%
Overdraft	Common	14,85%	20,54%	3,05%	21,37%	13,50%	2,88%
Overuralt	TOTAL	15,27%	20,85%	3,18%	21,73%	13,52%	2,94%
TOTAL RI	ETAIL	1,62%	22,41%	0,36%	2,12%	16,16%	0,34%

Table 4.18 - Risk parameters of the Retail segment post-acquisition

The total number of customers belonging to the Retail group is around 11.056, with a nominal value of \notin 542M and a pre-acquisition RWA of \notin 222M, which is considerably higher than in the Retail Enterprise segment, due to higher exposure and riskier customers. As far as post-acquisition valuations are concerned, by calculating a weighted average of the various parameters and the number of customers influencing them, it is possible to reach the conclusion, as far as the models in use are concerned, that a default rate of 1,6% and LGD of 22% are expected, resulting in an expected total loss of 0.36%. Similarly, the values of the models in validation lead to an expected loss of about 0.34%. The values of the various parameters shown in the figure were calculated taking into account the standards that North Bank uses to assess its clients through benchmarking.

The PD values are all below the 3% threshold, with the exception of the Pool Overdraft portfolio, whose exposure, however, is so minimal as to be considered negligible. Similarly, LGD values are also low, with a small exception for the Instalment Pool portfolio, since the customers are private, and the collection processes are considered short without excessive expenditure of money. However, this simulation shows good materiality of the parameters and good comparability with the standards adopted by North Bank.

Finally, we can conclude the analysis of performing portfolios with the last simulation of the impact of RWA in the Retail segment, presented below (*Table 4.19-4.20*).

	South 1	Bank (bef	fore	So			
	acquis	M)	aco	DELTA			
PORTFOLIO	NOMINAL	EAD	RWA	EAD	RWA	RWA DENSITY	RWA
Private Retail	507	491	202	499	204	41,0%	2
Instalment Pool	23	22	17	23	16	70,2%	-1
Pool Revolving	8	2	2	10	3	33,6%	1
Pool Cessione del Quinto	0	0	0	0	0	2,9%	0
Pool Overdraft	4	1	1	2	1	57,5%	0
TOTAL RETAIL	542	496	222	534	224	42,2%	2

 Table 4.19 - RWA simulation for production models

 Table 4.20 - RWA simulation for models under validation

	South 3	Bank (bef	ore	So			
	acquis	M)	ac	DELTA			
PORTFOLIO	NOMINAL	EAD	RWA	EAD	RWA	RWA DENSITY	RWA
Private Retail	507	491	202	498	177	35,6%	-25
Instalment Pool	23	22	17	23	11	49,0%	-6
Pool Revolving	8	2	2	4	1	23,7%	-1
Pool Cessione del Quinto	0	0	0	0	0	11,7%	0
Pool Overdraft	4	1	1	3	1	42,2%	0
TOTAL RETAIL	542	496	222	528	190	36,1%	-32
For what it concerns the Retail portfolio with the models in production, the total recalculated RWA is about \notin 224M and the calculated RWA density is about 42%: the simulation generated an increase in RWA of about \notin 2M. As regards the projection on the Retail portfolio with the validating models, the total recalculated RWA value is around \notin 190M and the calculated RWA density is around 36%: the simulation generated a decrease in RWA of around \notin 32M.

For the first time, there is a very small increase in RWA for production models. Although this is a small change considering the total portfolio, it is still to be seen as a slight increase in risk, probably due to the high riskiness of some segmented South Bank Retail customers. Nonetheless, the decrease in RWA emerges to be common to all performing portfolios. One reason may be found in the expansion of the merging bank's portfolios. Since RWA is a synthesis of all the risk factors that a bank takes into account when making a loan, acquiring portfolios means diversification and consequently a decrease in overall risk. The more different clients a bank has, both in terms of exposure and credit type, the more the bank will be covered against unexpected losses. The overall RWA will then decrease, despite the presence of individual clients who are more exposed to risk and default.

4.4.7) Non-Performing Portfolio

The Non-Performing segment indicates customers who have incurred a debt with the bank for which collection is considered risky. Although it corresponds to only a small fraction of total customers, it is the most complicated to manage as it is difficult to assess what the possible future scenarios might be. One ratio that is usually used to assess impaired loans is the coverage ratio, defined as the extent to which an impaired exposure is covered on the balance sheet, which allows a reliable numerical value to be assigned to the defaulted exposure. Compared to the bank's performing portfolio, the non-performing is significantly riskier, particularly due to the difficulty in the recovery process of non-performing loans. As mentioned above, the non-performing segment is composed of three risk categories which are "Past Due", "Unlikely to Pay" and "Sofferenza".

As regards the portion of South Bank's non-performing portfolio, *Tables 4.21* and *4.22* below show the nominal value and risk parameters of the portfolios based on the

alignment of the risk status for common customers and average risk parameters applied for the RWA simulation.

	South Bank (€/M)				
RISK STATUS	NOMINAL	EAD	RWA		
Past Due	5	4	6		
Unlikely to Pay	45	28	34		
Sofferenza	76	27	34		
TOTAL	126	59	74		

Table 4.21 - Risk parameters of the Non Performing segment pre-acquisition

Table 4.22 - Risk parameters of the Non Performing segment post-acquisition

	Models in j	production	Models in validation		
RISK STATUS	LGD	ELBE	LGD	ELBE	
Past Due	17,81%	17,06%	14,99%	13,76%	
Unlikely to Pay	41,55%	39,47%	46,86%	43,66%	
Sofferenza	75,24%	73,03%	75,24%	72,44%	
TOTAL	60,83%	58,73%	62,58%	59,72%	

The nominal value of the impaired loans amounted to €126M with an RWA of €74M, which is very high considering the small size of the merged company. Among these, "Sofferenza" represents the largest segment. The LGD and ELBE values are around 60%; if we consider that for performing portfolios these values were around 26% and 1% respectively, it is clearly understood how this segment is a critical point to be assessed and that it entails a significant cost for the bank. Since non-performing loans are impaired loans, whose borrowers are unable to repay, it is difficult to estimate how much the bank is required to hold as safety capital. Of the three main categories of non-performing loans, "Sofferenza" is certainly the most critical. While Past Due and Unlikely to Pay are impaired loans with a small probability of recovery, "Sofferenza" is considered completely unrecoverable due to the debtor's default. In a hierarchical order ranging from the least to the most serious of the three types of receivables, one would start from Past

Due, which simply exceed the 90-day limit and are not yet considered critical, then move on to Unlikely to Pay, which is unlikely to be recovered except through legal action, and finally to "Sofferenza". This hierarchy is also traceable to the values of the two parameters LGD and ELBE under observation. The more the probability of recovery decreases, the more these values increase, leading to an estimated LGD and ELBE for the "Sofferenza" segment of 75%, corresponding to a recovered capital of only 25% of the initial exposure.

With regards to the impact of RWA on the models in production and validation resulting from the extension, a summary is provided below (*Table 4.23 - 4.24*).

	South Bank	(before ac	quisition)	South Ba			
		(€/M)			(€/M)		
RISK STATUS	NOMINAL	EAD	RWA	EAD	RWA	RWA DENSITY	RWA
Past Due	5	5	6	5,5	0,5	10,50%	-5,5
Unlikely to Pay	45	28	34	45	13	28,80%	-21
Sofferenza	76	27	34	77	24	30,70%	-10
TOTAL	126	60	74	127,5	37,5	29,10%	-36,5

Table 4.23 - RWA simulation for production models

Table 4.24 - RWA simulation for models under validation

	South Bank (before acquisition) So				South Bank (after acquistion)		
		(€/M)			(€/M)		
RISK STATUS	NOMINAL	EAD	RWA	EAD	RWA	RWA DENSITY	RWA
Past Due	5	5	6	5,5	1	17,00%	-5
Unlikely to Pay	45	28	34	48	21	44,40%	-13
Sofferenza	76	27	34	77	30	38,80%	-4
TOTAL	126	60	74	130	52	39,90%	-22

The analyses developed on the non-performing portfolio lead, for the models in production, to a recalculated total RWA value of about \in 37,5M, with a decrease of about \in 36,5M. For what it concerns the simulation on the non-performing portfolio with the

models being validated, the recalculated total RWA value is around €52M and the simulation generated a decrease in RWA of around €22M.

If we want to make an overall assessment of the analyses and simulations of all the portfolios, we can say that, despite some critical points that still need to be studied, including the low value of the RWA density in the Enterprise Retail portfolio, there is good comparability of the values of the parameters in qualitative and quantitative terms between the two banks. The analyses were intended to follow a logical pattern that involved the transposition of South Bank's portfolios into North Bank's internal models to verify how the various parameters varied in the post-acquisition scenario and finally to determine the change in overall RWA. Now, having assessed these changes in absolute terms, i.e., taken as a separate entity from the overall portfolio that will be created after the merger, it remains necessary to conclude with the final simulations that will allow us to understand the real change that this acquisition will bring in terms of costs on the final entity. To do this, it will be necessary to assess, by means of statistical indices, that these analyses have not compromised the stability of the models by exceeding certain thresholds. Once these analyses are finalised, it will be possible to proceed with the final drafting of the simulations on a global scale (understood as North Bank + South Bank) and to proceed with the comparison with the thresholds imposed by the European Regulation in order to classify these changes deriving from the acquisition as nonsubstantial.

4.5) Representativeness analysis on PD, LGD and EAD parameters

The investigation described in the following sections focuses on the PD, LGD and EAD parameters that have been shown in the previous tables for the different portfolios. In the previous paragraphs, in fact, the values of the different parameters were shown for each portfolio both before the merger and through simulation for the post-merger.

The objective of the chapter is therefore to display the representativeness analyses carried out for each internal risk parameter on the basis of the Population Stability Index (PSI)²⁴. The PSI was calculated by comparing the distribution of the main risk drivers of the internal models and the thresholds used to define whether the test results are aligned with the AIRB model validation framework. In practical terms, the PSI indicates a measure of stability of the statistical model in use and assesses whether by inputting new values (in our case the South Bank parameters) into the model currently in use, it continues to perform and produce outputs that are consistent with its purpose. In fact, it could be the case that a large amount of data input into the models could compromise its stability, irreversibly distorting the value of the parameters. Therefore, such analyses are developed in parallel with impact simulations and play a supervisory role. The general formula most used in the banking sector is as follows:

$$PSI = \sum (\%Actual - \%Expected) * \ln \left(\frac{\%Actual}{\%Expected}\right)$$

where *%Actual* is the percentage of measurements on scoring variable in the actual sample (in our case on the pre-acquisition sample) and *%Expected* is the percentage of measurements on scoring variable in the expected sample (in our case on the post-acquisition sample). In the representativeness analyses on the three parameters, therefore, the guideline for the identification of some biases will be precisely the use of this formula for each portfolio and for each risk driver. For instance, the table below illustrates the different thresholds of PSI compared with the relative level of criticality (*Table 4.25*).

SIGNAL	LEVEL OF CRITICALITY	THRESHOLD
GREEN	Insignificant	$PSI \le 5\%$
ORANGE	Not very significant	$5\% < PSI \le 15\%$
YELLOW	Required some minor changes	$15\% < PSI \le 25\%$
RED	Major shift in population	PSI > 25%

Table 4.25 - PSI values associated with criticality levels

²⁴ The population stability index (PSI) is a statistic that measures how much a variable has shifted over time and is used to monitor applicability of a statistical model to the current population. It compares the distribution of a scoring variable (predicted probability) in scoring data set to a training data set that was used to develop the model.

As it can be inferred from the table, being the PSI a statistical index, the higher the value, the more critical the parameter will be, since the shift over time may have exceeded the thresholds imposed by the Regulation. Given the results achieved on the RWA, which attested to a smaller size of the overall risk following the merger compared to the previous one, it is expected that these levels of criticality will not exceed the threshold of 15%, which is considered a limit value for the correct measurement, as it would result in too high a difference of *%Actual* and *%Expected* which could distort the stability of the model.

4.5.1) Analysis of the PD parameter

The PD - or probability of default - is the probability that the counterparty defaults on its obligation to repay the principal and the interest accrued on it and is, together with LGD and EAD, one of the main factors determining the overall RWA. For each portfolio, the PD parameter was attributed - on common customers - by recovering the PD of the specific North Bank customer and - on exclusive customers - by applying the average PD of the North Bank portfolio with a default rate correction factor (TD) of South Bank in the presence of higher risk, using the following formula:

$$PD_{SouthBank} = \frac{(PDNorthBank * \frac{TD_{SouthBank}}{TD_{NorthBank}})}{\left(PD_{NorthBank} * \frac{TD_{SouthBank}}{TD_{NorthBank}}\right) + (1 - PDNorthBank) * (\frac{1 - TD_{SouthBank}}{1 - TD_{NorthBank}})}$$

For the analysis of the PD parameter regarding the main risk drivers of the internal models, a comparison of the pre-acquisition perimeter (North Bank stand-alone) vs. post-acquisition perimeter (North Bank + South Bank) was performed. The risk drivers taken into consideration were:

- Geographical area;
- Credit size;
- Segment type: considered only for models in production in order to cluster customers "Product pool";

• ATECO or type of classification of economic activities.

Below are the results of the representativeness tests relating to the comparison of the pre-acquisition and the post-acquisition portfolios (*Table 4.26*). The left-hand side of the table shows the portfolios considered with the risk drivers, while the right-hand side analyses the PSI values for both the production and validation models. The colours used in the table refer to *Table 4.25*, which assigns a different colour according to the level of criticality of the parameter.

		Models in	Models in	
ΡΟΡΤΕΟΙΙΟ	RISK DRIVER	production	validation	
TORITOLIO	KISK DRIVER	PSI exposure	PSI exposure	
	Geographical Area	0,04%	0,04%	
Corporate	Credit size	2,1%	1,9%	
	ATECO	N.A.	1,4%	
Fnternrise	Geographical Area	0,27%	0,27%	
Retail	Credit size	0,02%	0,03%	
	ATECO	N.A.	0,12%	
Private Retail	Geographical Area	0,4%	0,4%	
	Credit size	0,02%	0,9%	
	Geographical Area	1,1%	N.A.	
Pool - Overall	Credit size	0,00%	N.A.	
	Segment type	0,01%	N.A.	
Instalment	Geographical Area	N.A.	0,21%	
Pool	Credit size	N.A.	0,02%	
Pool	Geographical Area	N.A.	0,00%	
Revolving	Credit size	N.A.	0,5%	
Pool cessione	Geographical Area	N.A.	1,1%	
del Quinto	Credit size	N.A.	0,00%	

Table 4.26 - Overview of PSI values for the various portfolios

The results show a good representation of the risk drivers for the models in use and being validated on each acquired portfolio. It should be noted that these analyses lead to such low PSI values mainly due to the low significance of South Bank's perimeter in terms of exposure compared to North Bank. In fact, all the values reported are not only below the critical threshold of 15%, but none of them exceed 3% as well, which means that this change in the models due to the inclusion of the South Bank portfolios did not compromise the stability of the latter.

As a matter of fact, the test showed that, despite the inclusion of new exposures within North Bank's internal models, the values of the PD parameter did not undergo significant changes that would compromise its stability. This result shows a high degree of comparability with previous PD simulations where similarity in PD values was found between North Bank and South Bank. In this case, *%Actual* and *%Expected* have very similar values, due to the small influence that South Bank has on North Bank, making the PSI index close to 0%.

4.5.2) Analysis of the LGD parameter

The LGD parameter provides the percentage of amount that the credit institution would lose if the counterparty were to default, after taking into consideration any recovery, represented as a percentage of total exposure at the time of loss. In this case, the analyses performed were conducted on both the performing and non-performing portfolios, without distinguish any single portfolio and the main risk drivers examined were:

- Geographical area;
- Credit size;
- Collateral type, including personal and improper collateral and for which the same clustering was used for the models in production and validation;
- Court procedure: taken into account only for non-performing validation models.

As for the other parameters, the results obtained through the representativeness analyses for the performing and non-performing portfolios are shown below (*Table 4.27*).

RISK	RISK DRIVER	Models in production	Models in validation	
STATUS	KISK DATVER	PSI exposure	PSI exposure	
	Geographical Area	0,22%	0,22%	
Performing	Credit size	0,00%	0,01%	
	Collateral type	0,9%	0,9%	
	Geographical Area	4,11%	4,11%	
Non	Credit size	0,59%	0,39%	
Performing	Collateral type	10,2%	10,2%	
	Judicial Procedure	N.A.	2,21%	

Table 4.27 - Overview of PSI values for Performing and Non-Performing portfolios

The results show good representativeness of the risk drivers for the models in use and in validation on each acquired portfolio, even if the analyses show that the perimeter of South Bank non-performing is particularly concentrated on larger mortgage exposures that support a higher PSI value for the variable "Collateral Type". The PSI value for this segment is indeed close to 10%, which means that there could be a minimal distortion without having a strong impact on the whole model. Moreover, the fact that this value refers to the type of collateral for the non-performing portfolio, it should not create major problems as the impact would be very low. However, despite this value being partially above the threshold, the representativeness analyses inherent to the models in use and the models being validated lead to PSI values that are contained and below the "safety" thresholds. Further investigation of that risk driver could, however, lead to greater accuracy as well as additional safety for North Bank.

4.5.3) Analysis of the EAD parameter

The EAD parameter represents the amount of exposure the bank will owe to the counterparty at the time of default and depends on the amount the bank was exposed to at the time of default. In this case, the risk drivers examined are the same as for the PD parameter, except for ATECO, and the portfolios taken into consideration are performing and non-performing (*Table 4.28*). The main risk drivers are therefore:

- Geographical area;
- Credit size;
- Segment type.

RISK	RISK DRIVER	Models in production	Models in validation	
STATUS		PSI exposure	PSI exposure	
Performing	Geographical Area	0,24%	0,24%	
	Credit size	0,4%	0,4%	
	Segment type	0,027%	0,027%	
Non	Geographical Area	4,14%	4,14%	
Performing	Credit size	0,61%	1,35%	
	Segment type	1,29%	1,29%	

Table 4.28 - Overview of PSI values for Performing and Non-Performing portfolios

Also, in this case the results show no criticalities at exposure level. The parameters comply with the 5% threshold, highlighting the low influence, from a risk point of view, of South Bank on North Bank.

Although this type of analysis may appear purely statistical and almost superfluous for a bank merger, it serves as an indicator of the stability of the simulations being carried out and it is also explicitly required by the ECB in the Regulation. However, nowadays, even though the PSI is one of the most widely used indices for model monitoring, there are still no studies certifying its properties. The only rules that have been imposed, which are valid for any kind of test that is to be performed, concern the thresholds that must not be exceeded in order to be considered a stable model. These "rules" have been designed by studying the variation of the PSI value in many models in any field (benchmarking), through which it has been possible to ascertain that the interpretation of this value is unique, regardless of the model that was being faced.

4.6) Discussion of the main results and final considerations on RWA

The primary objective of the work was to carry out investigations on the different portfolios of the merged bank by simulating possible scenarios after the merger phase from a credit risk perspective. In particular, the main focus was on the deviation of the Risk Weight Assets for each portfolio, i.e., the variation of the main risk factors related to a given asset, whose purpose is to correct the nominal value of the individual assets, increasing in the case of riskier activities and decreasing in the case of less risky activities. From a practical point of view, this implies that the higher the RWA calculation, the more the bank will have to increase its capital buffers in order to avoid unrecognised losses. Therefore, the calculation and analysis of the risk parameters such as PD, LGD, EAD and EL, the study and evaluation of the main risk drivers and all the statistical models implemented, being summarized within a single RWA value, are of paramount importance, which is why it was necessary to achieve the most accurate results possible. This is the reason why even large banks feel the need to rely on major consulting firms, specialised in this area.

Although the analyses have focused on individual portfolios, to accurately assess and interpret the results achieved, it is necessary to look at the post-acquisition perimeter, consisting of North Bank and South Bank, and not just the specific portfolio of the specific institution. Therefore, the last examinations we are going to address will be on a global scale.

Before describing them, we present the summary of the expected impact on the overall RWA resulting from the extension of North Bank's internal models to the acquired portfolios, calculated according to the assumptions and methodological approaches described in the previous paragraphs. *Table 4.29 and 4.30*, indeed, are purely intended to summarise and unify all the results carried out before.

Table 4.29 - Summary of expected impacts on RWA before and after acquisition forproduction models

	South Bank – RWA (before acquisition) (€/M)			South B	DELTA RWA		
PORTFOLIO	Performing	Non Performing	Total (A)	Performing	Non Performing	Total (B)	(B-A)
Corporate	400	45	445	289	23	312	-133
Enterprise Retail	93	13	106	74	6	80	-26
Retail	223	15	238	226	8	234	-4
TOTAL	716	73	789	589	37	626	-163

 Table 4.30 - Summary of expected impacts on RWAs before and after acquisition for models

 under validation

	South Bank – RWA (before acquisition) (€/M)			South Bank - RWA (after simulation) (€/M)			DELTA RWA
PORTFOLIO	Performing	Non Performing	Total (A)	Performing	Non Performing	Total (B)	(B-A)
Corporate	400	45	445	262	32	294	-151
Enterprise Retail	93	13	106	49	9	58	-48
Retail	223	15	238	191	11	202	-36
TOTAL	716	73	789	502	52	554	-235

The tables above provide a summary and aggregation of all the data and studies performed in the previous paragraphs. In particular, the left-hand side of the tables illustrates the RWA situation of the merged company's portfolios before the merger, while the right-hand side shows the RWA after the acquisition. The last column, finally, shows the delta RWA, i.e., the change in the Risk Weight Assets of South Bank post-acquisition. However, these examinations only concern the situation of South Bank before and after the acquisition as a distinct entity, showing the RWA data that will later be included in North Bank's models, while it does not consider the change in the final total portfolio (South Bank + North Bank). In fact, since the merger will take place, the merged company will be incorporated within the larger one, making an overall global evaluation essential. For this reason, analyses were conducted to verify the impact of materiality on the increase/decrease in overall RWA in order to classify the changes as non-substantial,

which, according to EU Regulation 529/2014, provide for a maximum 15% reduction in the credit risk-weighted exposure amounts (RWA) associated with each portfolio. Through a general overview of the post-acquisition scenario, it will be possible to interpret these changes in RWA in percentage terms, as required by the Regulation, and to assess whether the 15% threshold is not exceeded. In order to do so, it will be necessary to take the RWA for each portfolio of both banks as separate entities and compare them with the RWA for each portfolio considering the two banks as a single entity. Only in this way will it be possible to effectively interpret the changes made.

Finally, to assess whether these thresholds imposed by the regulation have been respected, *Tables 4.31 and 4.32* shown below provide for the impact on the overall RWA for each portfolio resulting from the use of internal models on South Bank's portfolio. It should be noted that:

- the representations are inherent to the overall portfolio, thus including both the performing and non-performing portions;
- South Bank's initial valuation approach is Standard;
- the Retail portfolio includes both Retail individuals and product pools.

Table 4.31 - RWA impacts associated with each portfolio for models in production

RWA (€/M)	Corporate	Enterprise Retail	Retail
Initial RWA (North Bank + South Bank with Standard Approach) (<i>A</i>)	4.389	673	3.493
of which South Bank pre - simulation (B)	445	106	238
of which South Bank post - simulation (C)	311	80	234
Final RWA post simulation (North Bank+South Bank) <i>(A-B+C)</i>	4.255	647	3.489
Delta (<i>C-B</i>)	-134	-26	-4
% Delta <i>(C-B/A)</i>	-3,05%	-3,86%	-0,11%

RWA (€/M)	Corporate	Enterprise Retail	Retail
Initial RWA (North Bank + South Bank with Standard Approach) (<i>A</i>)	4.146	510	2.621
of which South Bank pre - simulation (B)	445	106	238
of which South Bank post - simulation (C)	294	58	202
Final RWA post simulation (North Bank+South Bank) <i>(A-B+C)</i>	3.995	462	2.585
Delta (<i>C-B</i>)	-151	-48	-36
% Delta (C-B/A)	-3,64%	-9,41%	-1,37%

Table 4.32 - RWA impacts associated with each portfolio for the models under validation

The value of initial RWA is given by the sum of the initial RWA of North Bank and South Bank using the Standard approach while the value of the final RWA is given by the sum of North Bank's RWA and South Bank's RWA using the AIRB method (approach used by the merging bank). Finally, the last part of the table shows the RWA deviation, both in terms of numbers and percentages, which corresponds to the final target we had set at the beginning, as well as values inspected by ECB.

Following the examinations of the North Bank and South Bank portfolios and the related impact on RWA following the acquisition, the final value of RWA compared to the initial value differs, with regards to the models in production, by around 3% for the Corporate and Enterprise Retail portfolios and by around 0.1% for the Retail portfolio. For what concerns the models under validation, on the other hand, the changes made have modified the RWA by approximately 10% for the Enterprise Retail portfolio, a higher value than expected but still below the 15% threshold imposed by EU Regulation No. 529/2014, for which the classification of the changes as non-substantial and subject to notification to the Supervisory Authority before implementation is confirmed. In the event that - on the basis of the representativeness, comparability and materiality analyses required by EU Regulation - the thresholds were not met and extension requests had to be transmitted, resulting in a longer authorisation process, South Bank's portfolios would have continued to be treated with the standardised approach until the ECB received the authorisation order on the extension of North Bank's internal models.

From a practical point of view, one element that is commonly found in the two tables above and in the respective portfolios is the decrease in RWA. However, it is not quite correct to say that the post-acquisition scenario results in an overall decrease in North Bank's RWA since, upon merger, the RWAs of the two banks will be added together thereby increasing the overall total RWA. What decreases is the estimated post-merger RWA of South Bank. For instance, considering them as two separate entities would have resulted in a sum of RWA of ϵ 4,400M in the case of the corporate portfolio, while considering them as a single entity would now result in a value of ϵ 4,200M. Nonetheless, this does not mean that North Bank's total RWA post-merger has not increased, as RWA values grew from ϵ 3,900M to ϵ 4,200M. It would be impossible and illogical that with the increase in exposures due to a merger, post-acquisition RWA would decrease, but it can be said, if anything, that the increase is contained within certain limits.

The fact that the ECB, in the Regulation, speaks of both a decrease and an increase in RWA to define that a change is considered substantial and therefore subject to further analysis and review is no accident. Regulating an excessive increase in RWA, i.e., in risk factors, is certainly more than correct, as an excessive increase in risks could cause problems during the merger, but as far as the decrease is concerned, it should be seen in a positive light, as risks should theoretically also decrease. With the Basel II Accords, these issues have been thoroughly evaluated because, without a common regulation, many banking institutions, owing to complex financial instruments, were able to decrease their RWA and consequently the capital buffers they had to hold without properly addressing the real problems. Certainly, from the bank's point of view, holding less capital reserves, which could be invested elsewhere, would be an advantage, but from the point of view of the global financial market, the consequences would be very serious.

With regards to the incorporation case studied in this paper, it can be concluded that, following extensive analysis of the Corporate, Retail and Enterprise Retail portfolios, all the limits imposed by the ECB were met, as well as the percentage change in RWA which is below the 15% threshold. This means that the comparability of the two banks in terms of assessing customers' risks is to be considered acceptable, as are the values of the risk parameters that influence RWA.

The achievement of such results allows to state with certainty that it will be possible to proceed with the incorporation of South Bank's data into North Bank's internal systems and definitively conclude the merger process in the credit sector. Finally, the future developments of this project will entail the transposition of the new information into the unified IT systems, thus leading to the definitive formalisation of the incorporation.

5) Conclusions

The main objective of the essay was to analyse in detail the fundamentals of the credit risk models that banks use to assess their clients realistically and as accurately as possible. It is often taken for granted that the technology and digitalisation of recent years enable banks to predict the future and to set aside sufficient reserve capital to cope with any unforeseen event. However, the examinations conducted in this paper have shown how complex it is, despite the technological tools of today, to accurately estimate all the risk factors that may influence decisions and strategic choices within the banking sector.

Of all the risks, credit risk is to be considered one of the most influential and difficult to interpret in the banking area, which is why the study of the relevant regulations has been so thorough and to which much of the analysis has been devoted. If on the one hand theoretical examinations have led to the definition of standards to be followed for the correct calculation of credit risk, clearly setting out which and how to use the various parameters, on the other hand, it has emerged how putting these concepts into practice leads to considerable difficulties in quantifying the riskiness of customers in terms of money provisions.

The case of the bank merger studied, from a credit risk modelling point of view, in fact, has underlined the long regulatory process imposed by the ECB for the calculation of the parameters that influence the credit risk, highlighting the complexity of the statistical models in use. Starting from the assumption of defining the regulatory position of the two banks and assessing their comparability in qualitative and quantitative terms, it was shown how this merger, despite entailing a significant change in the exposures of the credit portfolios, complies with European and National Regulations and can therefore take place within the established timeframe.

After an initial theoretical analysis of the fundamental concepts underlying credit risk and the related regulations, the Corporate, Retail and Enterprise Retail credit portfolios of both South Bank and North Bank were studied in detail in order to obtain a general overview of the exposures and the relative risk values, which were taken as the starting point for the simulations. This was followed by a brief analysis of the customers common to the two institutions and then concluded with the impact simulations in the post-merger scenario. Such simulations were performed through North Bank's internal statistical models on each portfolio and showed good comparability in terms of risk exposure between the two merging institutions, thus complying with the thresholds imposed by EU Regulation no. 529/2014. As a matter of fact, the change in total RWA for each portfolio, simulated by including South Bank's exposures within North Bank's internal credit risk models, did not result in a percentage increase in RWA above the 15% threshold limit. All critical factors were then further assessed using a special stability index, the Population Stability Index (PSI), which validated the risk drivers of the respective parameters used and determined that the changes resulting from the merger were not substantial. Finally, considering these results, all South Bank's internal models, which were then considered as a single entity.

Critically analysing the results, it is possible to conclude that the small increase in risk associated with the acquisition of new exposures was the result of careful portfolio diversification that both banks adopted in the past and from which they now benefit. In fact, it will be this careful diversification and the realistic view of their clientele that will favour the acquiring institution's competitiveness at a national level in the future.

The merger by incorporation will soon be officially formalised in all its fiscal and legal aspects, enabling the Group to become one of the most important and influential banking realities in Italy.

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